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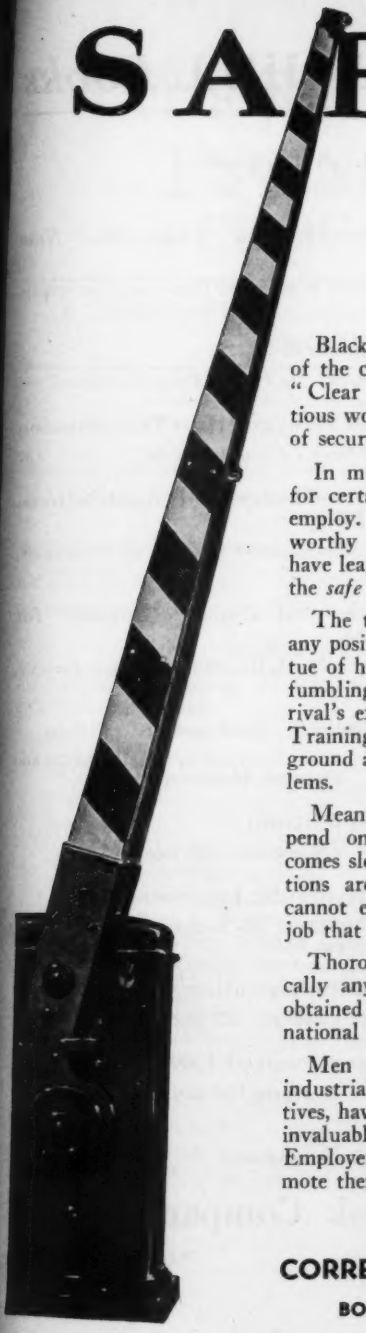

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AN ACTIVITY FOR SECTIONS AND BRANCHES

By GEO. W. CASE

Vice-President of the Society

There has been a marked increase in the effectiveness of training in engineering education in the past fifteen years. The Society has taken a prominent part in the activities leading to this result. The Board of Investigation and Coördination in its fact-finding survey was able to bring to the attention of engineering educators many conditions needing improvement, and its analysis and discussion of the data collected suggested breadth and balance in curricula, and in the summer schools conducted under its auspices the way was pointed out for obtaining better courses and teaching methods. Following closely upon the completion of the work of the board came the accrediting program of E. C. P. D. in which the Society is showing great interest and through which engineering education is being generously served. To some extent this program is also one of fact finding, although there is in it an effort to appraise quality and give reward for meeting minimum standards. Although to some these minimum standards are considered high, they leave much to be desired.

The stage is now set for the beginning of a third step in the improvement of engineering education and marked progress should be made in the next few years. This third stage should be one of study and the preparation of well-considered plans. Work should start before the stimulus of self-analysis, which has been an important part of the accrediting program, has worn off. The Society may furnish leadership in the preparation of these plans which should include consideration of such important items as curricula, content of courses, laboratory facilities, and teaching methods. The direct contact of the Society may well be through the activities of its Branches and Sections. In the Branch meetings suggested plans may be presented and discussed with members of non-engineering faculties invited in at certain times. Following these preliminary hearings the proposals may go to the Section meetings where the views of representatives of neighboring institutions may be obtained. In this manner problems and opportunities especially applicable to regions may receive full consideration. Such planning may provide a basis upon which to build an engineering curriculum that is well balanced and generally accepted by engineering educators and those in other fields as reasonably satisfactory.

CULTURAL PHASE OF ENGINEERING EDUCATION*

By J. W. CALHOUN,

President, The University of Texas

This topic is truly appalling in its length, breadth, depth, complexity, and obscurity. It has at least five dimensions. And, as the geometers tell us the difficulties encountered in dealing with spaces vary with the cube of the number of spatial dimensions, this subject must be about one hundred and twenty-five times as mixed up as a simple one way situation would be.

I approach this discussion not as an expert in either engineering or culture. An expert is one who has made surveys, sent out questionnaires, compiled data, calculated I.Q.'s, constructed medians, found out weighted averages, and has generally got himself so involved in his information that only an expert could escape getting completely lost in the maze. He gets somewhat in the state that Daniel Boone once confessed that he was in when asked if he had ever been lost in the forest. He replied that he had never been lost, but that he was once *bewildered* for two or three days! I expect, therefore, to acquire the scorn of both the experts in culture and in engineering.

Webster's Unabridged Dictionary has some eight or ten definitions of *culture*. The three that seem to have some bearing on the present discussion are as follows:

1. Act of developing by education, discipline, etc., the training or refining of the moral and intellectual nature.
2. The state of being cultivated; especially the enlightenment and refinement of taste acquired by intellectual and aesthetic training; the intellectual content of civilization; refinement in manners, taste, thought, etc.
3. Conversance with and taste in fine arts, humanities and broad aspects of science;—distinguished from vocational, technical, or professional skill or knowledge.

Cultural, which is the word used in my subject, is disposed of very briefly as: "Of or pertaining to culture." As Diogenes is credited with having spent a good deal of time and having subjected his lantern to considerable wear and tear as well as running

* Presented at the 46th Annual Meeting, S. P. E. E., College Station, Texas, June 27–30, 1938.

up a good sized fuel bill in his search for an honest man, so I have been for a long time trying to find some expert who could tell me in words of one syllable what is meant by culture and what subjects taught in schools could with safety and without fear of contradiction be called cultural. Up to date Diogenes and I are about tied as to our batting average.

But you are not interested in the labors of Diogenes or in my trials and disappointments. Let us, therefore, come to some sort of agreement, even though it must be arbitrary, as to what we shall mean by cultural subjects when studied by one preparing for a career as some type of engineer. We shall find it necessary to restrict ourselves even in the use of the word engineer since we now have social engineers, personnel engineers, advertising engineers, and for ought I know, political engineers! So when we use engineer in this discussion I propose to have it mean Mechanical Engineer. Not because this branch of engineering is more important than the others, or that I know less about it than about the others, for I am no judge of the former and I know equally little about all of them.

Our definitions of culture use the words: education, discipline, cultivated, enlightenment, refinement, moral, intellectual, æsthetic, civilization, humanities, broad aspects of science, vocational, professional, skill, knowledge. Here is an array of terms truly terrifying. We could not in a week of the most scholarly and etymologically profound discussion arrive at a common understanding of the meaning and significance of all those terms. It is a good deal like the state of mind in which the negro preacher found himself when informed by one of the over-educated members of his flock that the world was an unattached body spinning around in space. Said the Parson, "Tha's all foolishment, de yarth is not spinnin' 'round no whar and settin' on nothin', it sets solid on a rock." Says the upstart, "Well, den, Pahson, what dat rock sets on?" The Parson, "Why another rock, in course." "Well, den, what dat rock sets on?" The Parson, "Now look here, 'taint no use askin' all dem jack-assical questions, dey is rocks all de way down!"

Just so culture "sets" on education; education "sets" on discipline; discipline "sets" on enlightenment; enlightenment "sets" on civilization; and civilization in turn "sets" on culture, and we are back where we started. We have discovered perpetual motion.

Seeing that we get nowhere via the dictionary, let's cut loose from it and, using such sense as we have, see if we can agree as to what we mean by cultural education as applied to a Mechanical Engineer in contradistinction to what we mean by his technical, vocational, or professional education.

ARBITRARY CLASSIFICATION

Technical:

1. All courses in Engineering College.
2. All courses in College of Arts that are prerequisite to engineering courses.

Cultural:

1. Most College of Arts courses prescribed for engineering degrees.
2. Elective courses outside the College of Engineering.

I shall take the course of study as set out by The University of Texas for the securing of the degree of Bachelor of Science in Mechanical Engineering. Some of these courses are required for any bachelor's degree at the University, others are required for degrees not in engineering, some for any engineering degree, and still others for the degree in mechanical engineering only.

FOR THE DEGREE OF B.S. IN MECHANICAL ENGINEERING

Mechanical Engineering	44 sem. hours =	33%
Applied Math.	18	13%
Chemistry	6	5%
Civil Engineering	10	8%
Drawing	6	5%
Economics	3	2%
Electrical Engineering	10	7%
English	12	9%
Government	3	2%
Physics	12	9%
Elective	8	6%
Total	132 sem. hours =	99%

Mechanical Engineering

311—Manufacturing Processes
412—Mechanics of Machinery
420—Heat Engineering
240—Mechanical Engineering Laboratory (Instruments)
351—Heat Treatment and Welding of Metals
352—Thermodynamics, Steam, Boilers, Refrigeration, and the like
355—Machine Design
356—Machine Design—Drawing
357—Fluid Mechanics
363K—Continuation of 352
464—Power Plants—Maintenance and Operation
465—Machine Design
375—Industrial Engineering—Management, Organization, etc.
278—Mechanical Engineering Laboratory
279—Mechanical Engineering Laboratory

Civil Engineering	315—Applied Mechanics—Statics 220—Applied Mechanics—Kinetics 224—Surveying and Laboratory 333—Applied Mechanics—Strength of Materials
Electrical Engineering	35—Direct and Alternating Currents 436—Electrical Engineering Laboratory
Drawing	301—Engineering Drawing, Mechanical Drawing 302—Descriptive Geometry
Applied Mathematics	304—Trigonometry 305—Analytics 13—Calculus 325—Advanced Calculus and Series 326—Differential Equations
Chemistry	1—General Chemistry
Economics	312—Principles of Economics
English	1—Rhetoric and Composition 12—Outline of English Literature or 13—English Composition
Government	310—American Government—U. S., State, local, Constitutions of U. S. and Texas
Physics	1—General Physics—Mechanics, heat, sound, light, magnetism, electricity 12—Electricity and Magnetism—wave motion, acoustics, optics

Cultural

Applied Mathematics	18	semester hours
Chemistry	6	
Economics	3	
English	12	
Government	3	
Physics	6	
Sub-Total	48	
Grand Total—Electives	8	
Maximum	56	semester hours = 42%
Minimum	48	semester hours = 36%

After all, is not culture to a very large extent a matter of the personality of the individual? Do not people with essentially the same formal training and education display the widest variations imaginable in the evidences of what we call culture? Do we not find musicians and artists whose view of life is provincial and whose manners are boorish, while at the same time we see specialists in technology who are interested in the arts and the humanities and whose manners connote what we call culture? I am somewhat of a fatalist in some of these matters. A human being is not

like a stone from which a sculptor can carve a statue whose beauty depends only on the skill of the artist; a boy is not a canvas on which a painter can develop any creation that his imagination can produce. I am of the opinion that a great deal of the character one is to exhibit throughout his life is determined long before we school teachers get hold of him—perhaps even before he was born—possibly before his grandfather saw the light.

On the theory that our mechanical engineer is not a cultured person but is a competent engineer as far as his technical and professional training can make him so, then, unless he is over-trained in engineering or has some engineering education that does him no good or that he does not need, we must content ourselves with having him remain a barbarian or giving him such cultural education in addition to what he now has as to make him that desirable product for which all of us seem to be striving: a cultured mechanical engineer.

One way to secure a cultured engineer, if, indeed, culture can be deliberately imparted, would be to do what I have for a long time been advocating, though for another reason: this would be to change our engineering colleges into engineering schools. This seems to me to be particularly advisable in an institution whose ambition is to produce research engineers and consulting engineers —engineers in a really professional sense. This would call for two years of college training before admission to the engineering school. An applicant for admission to engineering would then be half way to a degree in the Liberal Arts College, and, ipso facto, half way toward being a cultured person; for, if the possessor of the degree of Bachelor of Arts is not possessed of culture, then, pray, how is culture to be obtained and where is it to be found?

Besides securing culture for engineers this plan would have many other advantages, for one it would greatly reduce the enrollment in engineering, a consummation devoutly to be wished, and would guarantee that a student before enrolling in engineering had given some indication of his ability to do work in mathematics and the natural sciences. What is needed is not more engineers, but better ones.

It is too often the case that, because a boy can install a fuse in the dining room or repair a short in the vacuum cleaner, he and his fond parents conclude that he is destined to be an electrical wizard of some sort. He enters engineering and his first year shows that he is a cripple in mathematics, a dub in physics, and not-too-good in drawing. But he is an engineer; he has been initiated into the mysteries of the College; has been introduced to the patron saint; has become a member of the clan, so to speak; and he regards it as

some sort of treason to desert now and go to Business Administration, Law, Pharmacy, or elsewhere, to a career for which he might be suited, and so he stays on, a permanent misfit in engineering.

If he had been enrolled in the College of Arts to begin with and had held engineering leanings, he would, of course, have taken up mathematics and physics as a part of his college preparation. When he found out that quadratic equations and conic sections were too much for him and that all he got out of his study of electricity was the shock of discovering that he could not comprehend it—that splicing a wire bore little relation to interpreting the action of galvanometers, rheostats and wheatstone bridges, he would naturally and without difficulty have turned to what for him were greener pastures; he would never have been an engineer, but he might have become cultured.

Suppose the engineer is not educated, is not cultured; that, instead of being a well-rounded man, he is a mere technician, a sort of intellectual robot; who or what is to blame? I am going to venture the opinion that professors of engineering are not wholly innocent. I have been rather closely associated with engineering professors for the last twenty years or more. A lot of my teaching has been done in a more or less successful attempt to teach mathematics to embryonic engineers. Even in a subject so essential and so basic to the whole aspect of engineering, I have always been quite certain that with certain rather rare exceptions the professors of engineering have either consciously or unconsciously indicated to the students that Math was a sort of academic affliction sent on them by the inscrutable educational powers and that, like measles and chicken pox and other juvenile ailments, it must be endured with such grace as can be mustered and got over with as little suffering as possible and forgotten with the greatest promptness. If there is such an attitude about so basic a matter as mathematics, what impression must the student get of the importance of English composition, foreign language, economics, accounting, and the like? I have seen a half year in calculus cut out to make room for a semester of the strength of materials. I am rather certain that the subject strength of materials can be mastered by anybody of junior rank in college without any instruction at all, but differential equations, Harmonic analysis, and Fourier's Series are usually mastered only by the help of a rather competent instructor.

Finally, the cultural phase of engineering education is in the hands of the professors of engineering. If they treat matters of culture as if culture were manly rather than the badge of a sissy;

if they lay some emphasis on the fact that there is a great world outside of the factory, the shop and the mine, that there is a world of music, of art, of literature and that it beckons to the engineer with the same welcoming smile as to the lawyer, the banker, the philosopher, the teacher, or the preacher; they will go a long way toward setting the feet of the young engineer on the road to culture and might even become interested in it themselves.

I am not at all certain that engineers are not proving disloyal to their profession in admitting that any of it lacks cultural value. It seems to me that it is all steeped in romance if we only had eyes with which to see and were not too deafened by the clang of the hammer and the scream of the lathe to comprehend what is all around it. I am unable to believe that the sickle is an instrument full of poetic significance and the combine a mere noisy utility; why should poetry inhere in the adze and the trowel but only prose and rather poor prose at that be associated with the saw mill and the steam shovel?

The Greeks created art from the notion of Daedalus and his wings stuck on with wax as a means of escaping from a labyrinth, but when the engineer makes flying a reality no poet sings a lay—it is machinery and hence prosaic. Every dream set down by the prophets and the seers of the past has been brought to fulfillment by the engineer and the scientist, but still it is not culture, it is a soulless mechanism.

The dreams of the Argonauts have been rendered trifling by comparison with reality. The labors of Hercules become child's play set off against doings of the engineer. Aladdin and his wonderful lamp are piffling in comparison to modern wonders of communication and transportation. The tales of Sinbad the Sailor would attract no audiences in these days in competition with the explorations of the Glacier Priest on the recent expedition of the National Geographic Society expedition for the purpose of photographing Mount McKinley. The golden touch of Midas is puerile compared to the work of the mining engineer, and it seems that just as Midas somewhat overworked his gift, the engineer has brought it about that the best we can do with all the gold he has produced by touching the mountains is to take it to the mountains of Kentucky and bury it. The man with the muck rake in "Pilgrim's Progress" refused to look up and so he saw only the dirt on the floor. He never saw the frescoes, the mosaics, the stained glass and the jewels with which he was surrounded. I wonder if the engineer and those who consider his work have been similarly blind. The Cultural Phase of Engineering Education! Brethren, it is all cultural unless we are of those who having eyes see not, having ears hear not, and hearing do not understand.

By DEXTER S. KIMBALL

Dean Emeritus, Cornell University

All thinking engineers and engineering educators agree that if the profession is to rise to its highest usefulness and consequently to its highest public appreciation the curricula of the engineering colleges must be considerably broadened. Much writing and talking to this effect has been promulgated and a limited amount of experimentation has been performed but the progress has been barely noticeable. Yet the question will not down and eventually educators must face it in a large way. No thoughtful man will deny the vast importance of the old humanities to all men nor will he deny that so far as these fields of knowledge have disclosed fundamental truths they are of great and lasting benefit to all mankind; and all will agree that the engineering curricula could be greatly improved by the introduction of some of these old humanities. The problem is what humanities are to be introduced and how shall room be made for them in the already overcrowded schedules.

We may perhaps clear our minds on the first of these issues if we will lay aside such terms as "cultural" in favor of the term "liberalizing." The term "cultural" has come to signify the strictly literary pursuits or is confused with the refinement or personal polish often given by certain educational methods at the expense of solid internal foundation. A person may be very refined or "cultured" in thought and manner and still not be liberally educated. It may be noted that the need of liberal studies in professional courses was fully recognized by the Morrill Act which established the Land Grant Colleges from which has come the greatest impetus to engineering education. The Act provides for the maintenance of colleges "where the leading object shall be, without excluding other scientific and *classical studies* and *including military* tactics, to teach such branches of learning as are related to agriculture and the mechanic arts." Unfortunately the suggestion was not heeded or rather the rapid growth of applied science in engineering has occupied almost all of the time available for instruction. The result of the Morrill Act has been a highly mechanized country and a productive capacity in both agriculture and industry that has created problems of distribution in the solution of which the engineer has not been particularly helpful nor is he able to forecast what the results of his next great advance may be. The problems over which Congress wrestles in these days are the direct result of technical education in "agriculture and the mechanic arts." It is almost begging the

question to state that the engineer should have a better understanding of the result of his labors.

When we inquire of the colleges of liberal arts what specific subjects will liberalize the engineering curricula we are met with confusing answers, the most common recommendation being to send the embryo engineer for a time to the college of liberal arts the inference being that all subjects offered by that college are liberalizing to him. To this the writer takes strong exception. No study is of itself liberalizing and what is liberalizing to one man is vocational to another. Latin and Greek may be strictly utilitarian to the archaeologist while liberalizing to the engineer. A knowledge of some industrial pursuit will be vocational to the man who is making a living thereby while a knowledge of the same art may be very liberalizing to a divinity student. The student of the humanities and classics can lay no claim to liberal education unless he knows something about the great fields of science and industry and the human interests involved that surround and affect him for good or evil on all sides. The student of science and the man interested in industry will find many things made plainer and his horizon greatly enlarged by studying the recorded experience of those who have preceded him. No man in fact can lay claim to a liberal training if his education has narrowed his vision so that he sees only the importance of his own particular field; and the most liberal of studies may be very narrowing in its effects if it is not related to vital matters.

Granting that these assertions are true what is the logical approach to the solution of the problem. Of course if ample time were available it would matter less, which of many liberalizing studies the student follows. But it should be remembered that the time of the student of engineering is very valuable and that he should be out of college at a fairly early age and obtaining his practical experience. "Shotgun" methods of instruction do not here apply; they are too wasteful. I venture to make the following suggestions hoping that they may raise some discussion. It is assumed that instruction in English should be included in all curricula.

First it will be readily admitted that it is possible in four years to give the student a fair acquaintance with the basic sciences that underlie engineering, to give him a limited experience with the application of the same with a limited amount of instruction in English and perhaps a little elementary economics. And even this can be accomplished only by requiring at least 150 semester hours of the student for a four years course, a doubtful procedure at best. The larger the engineering content in the course the lower must be the liberalizing content. And it will also be readily ad-

mitted that it is not possible to develop an engineer, architect, lawyer or any other professional person by college courses alone. The best that can be done is about as outlined in the foregoing and to open certain doors of knowledge in the somewhat vain hope that the student will explore further in future years.

Lying closely adjacent to the professional field is that of economics. Indeed many phases of engineering are economic in character. In my opinion no engineering course is complete without a good course in elementary economics. The engineer is in need of such knowledge not only so as to be an intelligent citizen but also because the chances are three to one as shown by statistics that he will need it in the managerial side of industry. If to this can be added brief courses in accounting, money and banking, corporation finance, etc., so much the better.

My next choice would be history. Every man should know the story of his race yet very few engineers have sufficient historical background. Not infrequently the student's high school history consists mostly of a microscopic study of the history of the United States. Every boy should read the equivalent of Breasted's "Ancient Times" and should have some knowledge of Modern European History before he graduates from college. Equally important is industrial history which as yet has not been adequately treated or put in concise form for the use of students. In fact it would appear that a more extended knowledge of industrial history on the part of our legislators would be extremely helpful.

It is universally asserted that the student should be taught to write and speak his mother tongue correctly; but the desirability of a broad literary acquaintance is seldom discussed. I am one of the old fashioned men who believe in Latin as a basic discipline and that both French and German are useful acquisitions partly because of their professional usefulness and partly because of the mental poise that such studies bestow. But aside from this every engineer should have a wide knowledge of literature. It is not possible, probably, to give him extended instruction in literature in college but perhaps something can be done to awaken his literary curiosity and to develop reading habits. The late Dean Diederichs, who was a very well-read man, always insisted that if correct reading habits are formed in youth the problem of literary breadth would care for itself. Knowledge of this sort is not acquired by taking a few college courses but comes as the result of years of reading for the love of it. A course of reading based upon Dr. Eliot's Five Foot Book Shelf might have some merit. It might help many people simply to read the titles of this collection. And after all some men will become liberal-minded in spite of educational processes, while others though they may never leave

the atmosphere of liberal study, will give little promise of development along these lines. Some of the best engineers and scientists of my acquaintance are also among the most liberally educated and in some instances they did not obtain this training in college; in fact some of them have never been to college. On the other hand there are many eminent scientists and engineers who have had exceptional opportunities for liberal study at college but who have remained narrowly educated though standing high in their chosen professions. Men who are great scholars in one or more fields are often very narrow-minded and intolerant regarding other matters, while there are other scholars whose very presence is as refreshing as an ocean breeze. No one who has any knowledge of university communities would be so bold as to say that all students in so-called liberal courses will become liberal minded or that all of those who teach in colleges of liberal arts are tolerant and liberal minded.

It is possible of course to include in any four year curriculum that has adequate entrance requirements a limited amount of instruction in English, economics, accounting and industrial history without weakening appreciably the engineering content of the curriculum. And it is possible as an extra curricular activity to excite the literary curiosity of a portion at least of the student body. But beyond this horizon stretch the fields of sociology, psychology, philosophy, aesthetics, etc., etc., all of which are of value to the student as undergraduate studies, did time and inclination permit. Before discussing the time element a few remarks concerning inclination may be pertinent.

It is quite customary in discussing educational matters to speak of "the student." As a matter of fact there is no such person. No two students are alike in ability or disposition. Engineering students come from many different environments with varying home training and from varying levels in the social pyramid. On the one extreme is found the self-contained highly scientific man who is interested in *things* rather than people. He is akin to the inventor and difficult to interest in liberal studies. Yet he and his kind move the world. On the other extreme is the administrative type, interested in engineering as a means of admission into the industrial field and much more concerned with *people* than with things. He takes kindly to economics, accounting, psychology, etc. Between these extremes varying combinations are to be found. And it should be noted in passing that the opportunities for the engineering graduate have broadened tremendously in the last half centry so that all these varying grades of men are needed in the industrial field.

For this reason alone engineering schools have in times past erred greviously in endeavoring to pass this varied material through the same educational process, and it is little wonder that the death rate at times and places has been unseemingly high. And for the same reason it is erroneous to expect that all engineering students can be markedly liberalized. The educational philosophy expressed by Tranio to Lucentio in "The Taming of the Shrew" still holds good —

> "The mathematics and the metaphysics
> Fall to them as your stomach serves you;
> No profit grows where is no pleasure ta'en:
> In brief, sir, study what you most affect."

Progressive colleges of engineering are recognizing these conditions and making provision accordingly. Thus at Cornell University there are courses in civil, mechanical, and electrical engineering that are predominantly technical in character for those who are predominantly technically minded. But there is also a course in industrial engineering for those who are not so strongly drawn to the technical studies, and, still farther away from the strictly technical courses, there are options in administrative engineering in all three schools of civil, mechanical, and electrical engineering. The mechanical engineering option may be taken as an example, the non-technical content of the other options being closely similar. This mechanical option was established in 1931 and has been developed under Professor John R. Bangs. The technical content embraces 67 per cent and the non-technical courses 33 per cent of the curriculum. The non-technical content includes English, economics, industrial history, principles of business organization, accounting, statistics, money and banking, industrial relations, cost accounting, corporation finance, business law, industrial marketing, and public speaking. This curriculum, which has been highly successful, represents, probably, the limit to which the technical content can be reduced in favor of non-technical studies and still confer an engineering degree upon its graduates. All three curricula have been accredited by the Engineers' Council for Professional Development and have been registered by the Department of Education of the State of New York. The non-technical content in all three options is predominantly economic in character and there is little that can be classified as belonging to the old humanities. They rather belong to what the writer calls the *"new humanities."* In order to include the older humanities we must go farther afield.

The solution most usually offered for this problem is to follow the lead of law and medicine and require from two to four years

of study in a college of liberal arts, so called, before undertaking the study of engineering. The writer is not in agreement with that plan and would challenge it on several grounds. Admittedly this plan sets up an excellent screen for keeping out the obviously unfit and reducing the number of applicants, but it, also, I believe, keeps out many of the best minds, first by enforcing a heavy financial penalty and second by enforcing an academic requirement that may or may not be to the liking of the brilliant student and hence does him little good if indeed it does not waste much of his time. Furthermore it has not been demonstrated that this pre-professional training results in developing better citizens. Surely there is little in the performance of the legal profession that indicates high culture and I am not aware that the medical profession is any more prominent in civic good than is the engineer. I am of course open to contrary conviction but these are my opinions based on a long period of observations. Furthermore the circumstances in the professions of law and medicine are not parallel to those in engineering. Neither law nor medicine has any special roots in the high school. But a student is no doubt better fitted for studying law after he has had some college work in history and economics. Medical schools usually require a certain amount of training in college physics, chemistry and biology, though apparently three or four years of college work is not needed for the requirements in either case.

There may be something in the contention that pre-professional study is necessary to develop a mature mind but it should be remembered that genius flowers early and should not be discouraged by unnecessary obstacles. The engineering student on the other hand starts his career in high school with mathematics, physics, chemistry, drawing, shopwork, etc., and in most engineering colleges continues these studies in his first year unbroken. It is highly imperative that these threads not be broken. They are the studies in which he is or should be interested, and in which his "stomach serves" him. The first two years of the engineering courses are normally and naturally taken up largely with the scientific basis of the profession. If the train of thought is once broken it is difficult to recover it again. The apathy with which freshmen engineers view such studies as English, foreign language, economics, etc., is quite familiar to all but it may not be so well known that if such subjects are presented to him a little later on when he is somewhat more mature and has had his technical curiosity satisfied by a few stiff courses in calculus, mechanics, etc., he will take to liberalizing subjects much more readily. Furthermore, such instruction in the later years of the course is much

2 HYGIENE	4 BUSINESS AND INDUSTRIAL MANAGEMENT			4 ELECTIVES
1 INTRODUCTORY LECT.			3 MONEY AND BANKING	
1 INTRODUCTORY LAB.	3 ECONOMICS			3 CORPORATION FINANCE
1 WOODWORKING			3 BUSINESS STATISTICS	
2 SURVEYING	2 TECHNICAL WRITING			3 PUBLIC SPEAKING
DESCRIPTIVE GEOMETRY AND DRAWING 6	3 ENGLISH		6 ACCOUNTING	
	2 GRAPHICAL COMPUTATIONS			6 INDUSTRIAL MARKETING
	2 MACHINE SHOP			
6 CHEMISTRY	1 FOUNDRY		ELECTRICAL	
	1 PATTERN SHOP		8 ENGINEERING	9 BUSINESS LAW
	MATERIALS OF			
	6 ENGINEERING			3 COST ACCOUNTING
8 PHYSICS	2 KINEMATIC DRAW.			2 INDUSTRIAL RELATIONS
			6 MECHANICAL	1 NON RESIDENT LECTURES
	3 KINEMATIC REC.		LABORATORY	3 HEAT POWER
	2 HYDRAULICS		2 MACHINE DESIGN DRAWING	
ANALYTIC GEOMETRY AND CALCULUS 10	STRENGTH OF		2 MACHINE DESIGN RECITATIONS	MECHANICAL
	3 MATERIALS			8 LABORATORY
	5 MECHANICS		6 HEAT POWER	
				8 INDUSTRIAL ENG.
39 HOURS TOTAL	39 HOURS TOTAL	36 HOURS TOTAL		30 HOURS TOTAL

more effective than in the first two years. Experience has demonstrated the truth of these statements.

If then the course is to be lengthened, my suggestion is that it be extended at the *end* of the course rather than at the beginning. And rather than turn the engineering student over to the liberal arts faculty that does not understand our problem (and in fact is having a difficult time with its own educational problems) I would build an expanding wedge of economic and humanistic studies starting somewhere around the sophomore year and broadening upward through five years, the engineering content narrowing upward to compensate and keep the credit hours at a proper limit. This plan has the advantage of permitting a sequence in the liberalizing courses that is not possible when they are crowded into two pre-engineering years. It also makes it possible to present some real mature instruction in economic and liberalizing studies in the last two years.

This is the principle that has been applied in designing the curricula in industrial engineering, administrative engineering and the optional five year course at Cornell. The accompanying diagram shows the content of the curriculum in the administrative option of mechanical engineering. The vertical distances are proportional to the credit hours in each course. The expanding wedge of liberalizing studies is shown between the heavy lines, the technical courses in each year being listed from the bottom upward to the first heavy line. The first year, which is common for all students in the college, it will be noted is practically all technical, thus laying a foundation of elementary science. The broadening work of the second year includes economics and some industrial history in the course in Business and Industrial Management. The succeeding liberal studies are largely derivatives of these basic courses. Like most engineering curricula in the country, it is open to the criticism that it is too heavy, the total required credit hours being 150. It is doubtful if we ever really get that amount of exertion except perhaps from a few exceptional men.

The application of this principle to any five year curriculum with additional courses in broader humanistic studies is quite obvious. The optional existing five year courses referred to embrace the technical content of the more technical curricula and, in the case of the five-year course in Mechanical Engineering for instance, includes 51 credit hours of non-technical studies which allows ample scope for liberal instruction. These 51 hours are arranged for the student through consultation with his faculty adviser, but he is given wide latitude in his choice which is as it should be for best results. The distribution of these hours is as follows—first year 2, second year 6, third year 11, fouth year 10 and fifth

year 22, and the grand total for the five years is 185 credit hours.

I believe that curricula such as these are the next logical step. If the non-technical content is carefully chosen and if in addition the liberal courses are specially planned so as to be highly efficient as to time and conducted by teachers having this particular problem in mind much of the criticism of the narrowness of the engineering curricula would be removed. For financial reasons alone such a course, can not compete very successfully when placed along side of the regular four year courses. For many years Cornell has offered the optional five year course referred to for those who desire a broader curriculum than the standard four year courses. For many years also Cornell has offered a six-year course leading to the degree of A.B. at the end of the first four years and an engineering degree at the end of the sixth year. For the first four years the student is registered in the College of Arts and Scinces, his courses being arranged so that at the end of the first four years he is prepared to register in the College of Engineering as a junior. This is an excellent course and answers fully all of the criticisms that have been made of the narrowness of technical education. But neither of these curricula has been popular as compared to the four-year courses, the principal reason probably being monetary. Unless all engineering colleges go to a five-year basis, as the colleges of architecture have done, there is little hope of broadening technical instruction in this country. It is an open question whether we are ready for this step, for it would place an additional financial load on many of our best students who now have difficulty in paying their way and sufficient scholarship funds are not available to care for them.

Of course it is difficult if not impossible to measure the results of liberal studies in technical schools, but it may be that colleges like Columbia with its required five year curricula and Leland Stanford with its two-year lower division and four year engineering superimposed thereon could throw some light on this most important problem.

By R. A. SEATON

Dean, Division of Engineering, Kansas State College

Since the theme of this convention is "The Cultural and Professional Phases of Engineering Education," and since one group of papers on the program is assigned the title "Professional Phase of Engineering Education" while another group is given the title "Cultural Phase of Engineering Education" it might be assumed

that these two phases are separate and distinct matters, unrelated except as they both contribute to the total education of the engineer. This assumption is, in fact, often made or implied in discussions of engineering education and particularly in discussions of the courses in engineering curricula. Certain courses are considered to be strictly technical or professional, while others are included solely or chiefly for their cultural value.

I do not believe this assumption is a valid one, nor do I believe it was intended by those who formulated this program. In my opinion, the cultural and professional phases of engineering education are closely interrelated, and the cultural phase is just as necessary to the attainment of true professional status by the engineer, as is the professional phase. It appears to me that a broad general understanding of the social and economic implications of life's work, a comprehensive grasp of humanity's vital problems, and a sympathetic appreciation of mankind's interests, activities, ideals, and aspirations—which constitute the aim and essence of culture—are essential elements of difference between the truly professional engineer and the mere technical expert.

Neither do I believe that a sharp division of the courses of the curriculum can or should be made into those which are strictly professional and those which are strictly cultural. Recently a college president who is truly liberally educated was given a statement of the typical distribution of subjects in chemical engineering curricula as prepared by the educational committee of the American Institute of Chemical Engineers. This statement lists so many per cent, each, of chemistry, chemical engineering, other engineering, mathematics, physics, mechanics, and other sciences, and fifteen per cent of cultural subjects. The president's terse comment was "All these are cultural." I quite agree with him. All courses of the curriculum can be and should be so taught that they contribute both to the cultural and to the professional education of the engineer—to his broad understanding and appreciation of humanity's problems, ideals, and interests, and to his preparation for a useful part in helping to solve these problems and to promote these interests through his professional career.

An engineering education should not be regarded solely as training for making a living, as is unfortunately often done by engineering students, their parents, and friends. It is this and more. Primarily, it is an education for a useful life, in which one may not only earn a livelihood but may derive deep personal satisfaction and enjoyment as well. How much simpler our problem as engineering educators would be if our students, early in their college careers, would realize the necessity of acquiring a liberal education or "culture" which would lead to a broad general under-

standing of all the implications and social obligations and opportunities of the profession for which the technical training is provided, and if we could instill in them an intense desire for high intellectual achievement instead of merely a desire to get, with as little effort as possible, a knowledge of certain procedures and techniques which will enable them to make a good living!

Webster defines education as "the totality of the qualities acquired through individual instruction and social training, which further the happiness, efficiency, and capacity for social service of the educated." Engineering education should fit perfectly into this definition. It cannot be narrowly technical and do so. Nor can it fully achieve its purpose as a professional training if it is narrowly technical. Engineers do not deal solely with materials and forces of nature. Much of their work is with money and men, and with the organized activities of society, and they must understand and be able to make use of the less definite and less tangible relationships which exist in social and economic fields as well as those in the fields of materials and forces, if they are to handle their work with money and men successfully. Certainly this necessity calls for cultural training, and yet, as certainly, the objective is a professional one.

In the "Report of the Investigation of Engineering Education" the Board of Investigation and Coördination of this Society states:* "The basic process of engineering education should be an undergraduate curriculum of coherent and integral structure, directed to the grounding of the student in the principles and methods of engineering and to those elements of liberal culture which serve to fit the engineer for a worthy place in human society and to enrich his personal life. . . .

"An educational process appropriate to these purposes cannot be narrowly technical. Given a proper choice of subject matter and activity, reinforced by the incentive of purpose, the inspiration of professional ideals, and the effect of a professional objective in bringing the entire process to a focus, the result of engineering education should be a sound, general development, worthy to be compared with the result of any other collegiate program. In short, good engineering education is good general education. . . ."

How shall these "elements of liberal culture" in an engineering education, which make it a "good general education" be secured?

A young man's education for the profession of engineering does not begin when he enters college, nor does it end when he graduates from the college with his engineering degree. Through

* Volume I, page 84.

his earlier years his parents, his home environment, his playmates, and his experiences contribute much to his education. His grade-school and high-school studies; the books, magazines, and papers he reads; his teachers, his associates, and his employers; his amusements, his work, and his other pre-college experiences; all these make contributions of good or ill to his education, and this education is as vital a part of his education for the engineering profession as that he is to receive in the engineering college. It has extended over a period of eighteen years, more or less, while the normal length of his education in the engineering college is only four years. During this pre-college period he will ordinarily receive little or no technical or professional training, but he should acquire considerable training of cultural value, not only through the high-school courses in English, foreign language, history and government, social studies, mathematics and the physical and biological sciences, but also through all of the other media which have been mentioned. The amount of such cultural training will, of course, vary greatly with the individual student and the influences to which he is subjected, but in all cases it should be of much value to him in his preparation for an engineering career.

This early cultural training must be supplemented in college upon a more advanced level, and deficiencies in it must be made up so far as is possible. The better engineering curricula do provide a considerable amount of general course work distributed through the four years. In the "Report of the Investigation of Engineering Education" already mentioned the statement is made* "It is . . . conservative to state that the average engineering curriculum includes the equivalent of more than two years' formal training in a college of liberal arts." Since this study was made, the general content of the better engineering curricula has probably increased rather than decreased. While these general studies are chiefly scientific, rather than humanistic, yet English, history, economics, and military training are commonly included as required courses, with foreign languages, sociology, psychology, political science, business training, music, history of architecture, ethics, art, professional education, and many other subjects available as electives. Further, in a technological civilization such as that in which we live, a sound scientific training is essential to a comprehensive grasp of humanity's vital problems and is therefore as necessary to the attainment of a true liberal culture as is a study of the so-called humanities. As President Harvey N. Davis of Stevens Institute of Technology stated

* Volume I, page 553.

in a recent radio address:* "The sort of training that the more forward looking engineering schools offer may well be, for men suited to it, the best sort of a liberal education for life in this twentieth century."

But as has already been pointed out, the general courses in the engineering curriculum should not be the only cultural courses. All of the courses should be cultural. In order to realize this ideal, the teachers of these courses must themselves possess culture —they must be men of broad knowledge and understanding, who will instill into their students the love of truth and beauty in all their forms; who will cultivate in their students the ideals of self-respect, of self development, and of self-directed individual responsibility. The technical courses themselves should not be narrowly technical any more than the engineering curricula should be, but should include the historical backgrounds of their subjects and should touch upon the social and economic as well as the technological implications of their development and application. Would that there were more textbooks covering these phases of their subjects adequately!

But the cultural training of the engineering student's college career is not confined to the classroom. As in the pre-college period, many other influences are at work. The whole environment of the student and all of his activities, outside of the classroom as well as in it, are—or may be—effective aids in this training. The student's associates among the students, faculty members, and others; the social organizations—fraternities, sororities and other groups; his amusements and recreations—dances, parties, the theater, the radio; his outside reading; the student activities in which he participates—athletics, student government, the Y. M. C. A., student politics, engineers' day activities, debates and other contests, student publications, honorary societies and organizations, student branches of the professional engineering societies; and the work he does toward earning his expenses either in vacation or during the school year; all of these and many other things make their contributions to his cultural development.

Orientation and counselling activities, well organized in some engineering colleges and carried on to some extent in nearly all of them, may be most helpful. At Kansas State College, and doubtless at many other schools, copies of the series of talks on Developing a Pleasing Personality by Dean W. W. Charters of the University of Pittsburgh and the little booklet on "The Technique of Good Manners" by Mary Perin Barker have been found very useful.

* "The Engineering School as a Liberal Education for Life in the Twentieth Century," as published by Eugene Dietzgen Co., page 6.

Are these cultural influences—the pre-college training, the general and technical college courses, the student's associates and environment, his reading, his recreation, his activities, and his experiences in college, and the orientation and counselling he receives—are these adequate to give him "a broad general understanding of the social and economic implication of life's work, a comprehensive grasp of humanity's vital problems, and a sympathetic appreciation of mankind's interests, activities, ideals and aspirations?" The student is too immature, the college period is too short and too crowded, and the influences fall too far short of the ideal for this to be accomplished in many cases.

As I have already said, a young man's education for the profession of engineering does not end when he graduates from college with his engineering degree. The cultural phase of his engineering education, as well as the professional phase, must be continued into the post-college period. The Engineers' Council for Professional Development, in its Minimum Definition of an Engineer, specifies not less than four years after graduation from an approved engineering school as the minimum time in which a young engineer can be expected to reach full professional status. During this period the cultural development should parallel and keep pace with the professional development, and it is of equal importance in the achievement of true professional competency. Far too often the young engineer does not appreciate this fact and neglects his cultural opportunities, or at least does not fully utilize them.

There are evidences, however, that many young engineers do realize that their cultural development is inadequate when they graduate, and needs further attention. In a recent questionnaire sent to members of the last ten graduating classes of Case School of Applied Science, President Wickenden asked the question: "What, in your opinion, is Case's most outstanding deficiency?" The answers are most illuminating. Of 376 replies received, 217, or well over one-half of the total, relate to the cultural development of the student. Insufficient business training was mentioned in 69 replies; insufficient training in speaking, writing, and self expression in 36; lack of cultural and intellectual breadth in 34: development of personality and personal orientation in 31; training in personal relationship in 27; and work too specialized, more work in other departments, and inadequate social opportunities in lesser numbers. Such cultural training and development at Case is probably no more deficient than in most other engineering schools, and the replies may probably be taken as fairly representative of the opinions of most recent engineering graduates from all the schools.

The encouraging feature of the situation is that the replies indicate that the young engineering graduates themselves do, in considerable numbers, realize the insufficiency of their cultural development. This should, and doubtless will, in many cases, stimulate them to supplement the cultural training received in the college and pre-college periods. How can this be done? Many opportunities exist for those who will take advantage of them, and more should be made available.

The Committee on Professional Training of the Engineers' Council for Professional Development is alive to this need, and has already done much to bring to the attention of junior engineers the opportunities now existing for further cultural as well as professional education, and to extend these opportunities. Its pamphlet "Suggestions to Junior Engineers" grew largely out of the broad experience of the late General R. I. Rees, head of the educational department of the American Telephone and Telegraph Company and past president of this Society, in helping young graduate engineers in their problems of post-collegiate education and professional advancement. It was published * "to assist those who are looking forward to an engineering career in obtaining a broader appreciation of their own interests and abilities and in planning a definite program of self-development." In addition to wholesome counsel to young engineers, it includes a personal appraisal and self-analysis blank, and an annotated suggested reading list in the fields of natural science; philosophy, including religion; economics and sociology; psychology; business and industrial management; literature, including poetry, essays, and fiction; history; biography and travel; fine arts; and general matters. In my opinion a copy of this pamphlet should be placed in the hands of every young engineer. It has been my own practice for several years to send a copy to each senior engineering student of Kansas State College shortly before his graduation.

Other activities of the E. C. P. D. Committee on Professional Training to aid the further cultural development of the young engineer have included publication of a pamphlet "University Extension Facilities" giving a list of 24 institutions with descriptions of non-technical courses available to practicing young engineers, given by class study or by correspondence; and the promotion of the organization of study groups of young engineers in industrial centers under the sponsorship of local sections of the professional engineering societies and other groups of professional

* Available from the Engineers' Council for Professional Development, 29 West 39th Street, New York, N. Y., at 10 cents each or $5.00 per hundred plus transportation.

engineers. Many such study groups, about 40 or 50, have already been organized and are carrying on successfully.

The whole-hearted coöperation of engineering teachers and of practicing engineers is needed in bringing this program of the E. C. P. D. to the attention of young engineers and in helping to make it an effective aid to the cultural and professional development of the young engineer.

And so the cultural phase of engineering education, which is just as necessary to the attainment of true professional status and accomplishment as are the technical and professional phases, begins in infancy and should continue to the end of the engineering career. Teachers in engineering schools can and should play an important part in this phase of engineering education by providing suitable courses in the curriculum; by so teaching all courses, both technical and general, that they will be cultural; by providing a suitable environment for the engineering student in college; by fostering suitable student activities; by counselling and orientation programs; by inspiring in the student a love of truth and beauty and an appreciation of the finer things of life; and by stimulating him to continue his cultural study and development throughout his whole career.

DISCUSSION

By J. B. THOMAS

Texas Electric Service Co., Fort Worth, Texas

Customer analysis is being used in a great many businesses, trades and professions these days. You send out to see what the customer thinks about your product. My background is that of apprenticeship in a machine shop, a course in this school, a good many years in active engineering practice, and the last ten years in trying to help administer a utility business that uses a great many engineering graduates. It has been my pleasure and duty to employ a good many hundreds of your product and try to make them useful in an industry that requires many such men; so that I may be qualified to give you a customer's reaction on your product.

I have enjoyed these excellent papers presented this morning. I was particularly responsive to a point President Calhoun made in that apparently naïve but quite well calculated paper of his. He said many of the attributes of these men you train were determined one, two, or three generations ago. I believe that. I have talked with Dean Bolton often and I suspect that half the men who go through the engineering courses have no business here, but I would be the last person to stand at the gate and say to this one, "You go by," and to this one, "You go in." I do not know how to do that.

In order that we may understand each other, in these last three or four years I have been quite active in the rear guard action of the retreating group of those who believe that men with better than average faculties and a willingness to work, and the thrift to keep what they earn, should be allowed to keep and hold and administer a part of that which they get.

My definition of culture is arrived at somewhat by the subtraction process. I like to think of it as that knowledge and training in what has happened to people and what is happening to them, that lets you understand their ideals and their motives, and those things that make for better and more pleasant living and getting along. I have, in common with you gentlemen, the desire to see the engineering profession take its proper place in the leadership of our country, and our economic and social progress and our governmental functions as well. I think, as things become more highly complicated and technical, it is more and more fitting that

the engineer should take social responsibility and, in addition to being born with the attributes of leadership, should have some training in that respect.

Today's conditions remind me of an incident that happened on a trip to West Texas recently. There I ran into, in the headquarters of a large industrial group, two men: Sam, whom I had known for only a couple of years, and Pat, whom I have known 25 or more years. I said, "Pat, how are you getting along and who runs this place anyhow?" "Well," he said, "it varies; I do all the work and Sam does all the talking and does not do any work. When we are getting something done, I am on top; when we are just talking, Sam is in the lead." Gentlemen, I submit that out of the last four or five years it is time that the Pats and the rest of them who do things get in the lead and get something done, because the Sams are doing a lot of talking without getting very far. So I share with you the desire to have the attributes of leadership found and trained in these engineers, and many of them are cultural attributes.

It seems to me there are three phases of a man's training that allow him to assume leadership. I say that because having employed a great many of these graduates, it has been my experience that out of 100 taken into an organization, perhaps after three years there may be six of them who can take responsibility and who can execute their mission without detailed instruction and the closest supervision. In those three years those remaining have largely gravitated to the status of a technician where they will remain without a great deal more progress for the balance of their working period. That may sound cold to you; I hope others are more successful in developing these attributes.

There are three things that seem to me to be cultural that also seem to be attributes of leadership. The first is to understand the wants and the wishes of human beings and the motives that animate them—what makes them tick, what makes them work—and be able to apply your engineering knowledge to them. The legend of the wings of wax that was spoken about by President Calhoun a few minutes ago, was the expression of a desire of the human race to fly and get about in the air. It was time for somebody to develop your airplane and your flying craft. This legend of the siren the sailors told about—they wanted to hear the music, the expression, and something of the softness of the rest of the world while they went about their arduous journeys. We have it today—the radio on our ship and on our car.

Had we better not train these young men with a background of understanding of what the wishes and wants of people are? Had

they better not learn to express themselves and to turn out their products to fit human wants and desires? You remember when you started on a radio set and built one at home, and your wife would not let you keep that ugly thing anywhere except back in the kitchen or in the back of the house. At first, it was not pretty; it did not meet her ideals of beauty. Secondly, it was obviously so complicated and involved that she did not understand it and she did not want to have it in the front room. What happened when that was dressed up with a beautifully molded plastic case, little magic eyes, dials that were easy to read and easy to turn? She put one in the front room, one in the back room, one in the bedroom; and one in the car. It was tuned to fit the cultural desires, wishes, and the animating motives of people. That is what we have to do with the things we engineers turn out today.

The second attribute that I might call cultural, as I understand culture, is the ability of a man to express himself in the language and idiom of the recipient of the idea. It would be of no use in the world for me to try to address you in Chinese, if I had that happy faculty. I might be full of good philosophy and rich in story and color, but it would make no impression on you. I say these young men who are to take leadership must have the facility of quick and apt expression in the language of the recipient of the idea they are seeking to put across. They may not have to have the language of the platform speaker, but when they talk to a group of linemen, molders, or mechanics, they want to talk in their idiom. When they talk to the man on the street, they want to know enough of his way of living and what animates him to talk the language he understands. They must know to get out of their technical way of doing things and add depth and breadth to the picture they seek to make.

I have in my office a little set of blocks that cost about two dollars to make. They saved us in our operations $100,000 one year. They are simple little curves that any freshman could make, but I added to them thickness and made them of blocks of wood and colored them so that they might be distinguished one from another. Men who got no idea from the graphs I had, or from those complicated sheets of figures the accountants had turned out, saw and grasped what had happened to the thing in which they were interested, and they became convinced that the subject matter was sound. More than that, they became convinced of the integrity of us who sought to carry an idea across into expression in terms they could understand. Certainly, as a layman, I would say that not only the English language, but the mechanism and the idiom of at least one other language, are necessary to start a man's mind out on that track.

The third thing I am impressed with in this respect—it may sound simple or foreign to you—is an understanding of the rhythm at which people live; the speed at which thoughts go to them and surge back; and the poise to stand there and wait until the time comes to say what you have to say. Maybe you think that does not have anything to do with engineering education. I say it does. I say that any man who stands before a group of people to impress them, any man who works his way through an organization by selling his ideas and plans and schemes to those about him, has to have a true sense of rhythm and a poise to stand until the right time. Many of us in business—and perhaps you—have waited three, four and five years to say one sentence or express one idea that should be carried out. Waiting for what? Waiting for the time that the minds of those you sought to influence had come to the right point to say what you had to say and to do what you had to do.

I do not know how to tell you to give that training—the physical drill, the meter of a good poem, something of music, even the involved rhythm of classical music that some folks laugh at and at which engineers are prone to scoff; but which still trains you in that long repeated rhythm at which people live, think, and change their minds.

So, as a layman, I again repeat—and I do not know the mechaism for it—that these men, to be leaders, have to come to understand the things that animate people, have a background of what has moved them before, and know what their ideals and wishes are. They have to express themselves aptly and at the proper time in the language of the recipient of their ideas, and they have to feel the rhythm of people and have the poise to act at the proper time.

Then I have another thought for what it may be worth. There are those endowed by birth to lead, to move faster than others. I wish there was some way in educational institutions to give these men right of way, and let them proceed at the speed that their minds and capabilities will let them. It seems to me that is 100 times more important than trying to pace your school and your course to the mediocre or average fellow. I hold that a true democracy (I mean by that deciding things by a majority vote in all cases) brings about mediocre leadership and that progress is only made when those best fitted individuals get out in front and have the opportunity to take their places as leaders.

At the risk of being overbold, I want to make this suggestion, since we are talking about training engineers to take their place in the leadership of society: Leadership, to my mind, is the impression of a strong personality, its plans, wishes, desires, and habits of thinking, upon a group of people. You will not give the best training in leadership unless you, yourselves, gentlemen, have those

cultural accomplishments, the ability, and that training that sets an example. When you look for young men to go into your faculties, and as you choose from those about you to round out your group, I say you want to pick men with some cultural training, men who understand, men who can express themselves; and men who exhibit that rhythm and that poise they are going to have to have if they take their place in the leadership of this country, as I believe, heaven knows, it is time they began to do.

By C. W. CRAWFORD,

Head, Dept. of Mechanical Engineering, A. & M. College of Texas

In the foregoing talks, I have been impressed by the unanimous opinion that the primary purpose of any education is to enable a man better to discharge his responsibilities as a citizen and better to fill his proper place in society. I am glad that Dean Seaton emphasized that the Professional and Cultural Phases of an engineering education are not separate and distinct but that they both merge into a single complete unit. I heartily agree that all education is cultural if it is properly integrated and properly related to the society in which we live.

As has been pointed out, a man's formal education has already covered some thirteen years before he comes under the guidance and direction of engineering teachers. His home environment and this formal education has made a deep imprint which cannot be easily or readily changed. That thing, or the lack of it, is already evident and deeply ingrained. This leaves a tremendous responsibility on the shoulders of the engineering teacher and if he is to discharge it properly he must possess, in abundance, those attributes by which a cultural person is known. He must also take a part of that time allotted to him for his class work and use it in such a way as to inspire in his students a desire to acquire as much culture as possible. I wonder if it is a matter of the number of credits or the amount of time given to the so-called cultural subjects or, if it is a matter of a concerted effort on the part of all of the instructors to create the proper attitude of mind in the student, which makes him desire to reach such a coveted goal. If such an attitude can be created the student's reading and outside activities will go far to take care of any deficiency in curriculum.

In discussing the theme of our S. P. E. E. meeting with our librarian, Dr. Thomas F. Mayo, I was much interested in his point of view, as one outside of the engineering profession, and the way in which he drew the distinction between Culture, Polish, and Re-

finement. He defined culture as that knowledge which a man gains in any field over and above what he needs satisfactorily to discharge all of his duties, for the sake of the knowledge itself. If this be true, then every subject which is taught can be made cultural. The field of mathematics, physics, mechanics or thermodynamics can be taught in relation to its background and application so as to produce real culture. A hobby, such as photography, or flower gardening may produce real culture. I like to think of culture in this light and when we do we can readily see why such subjects as history, psychology, economics, English literature, poetry and the like are usually called cultural subjects. Also, we can see that our own students may be deeply cultural in certain fields and yet not widely cultured.

Dr. Mayo defined polish as a man's ability to convey to others his own ideas and feelings. As you can see this is a matter of degree. Some people can convey to others effectively and accurately their thoughts, feelings or emotions. Someone has said that a polished man is never unintentionally rude.

Refinement was defined as the ability to distinguish between what is right or proper and what is not quite right or proper.

Whether or not we make the above distinctions in what we usually call culture we are agreed that we want our engineering graduates to possess these qualities. As Dean Seaton pointed out, we cannot expect the student to get it all in the class room. Our campus activities are vital factors and among these are our technical societies. They can and do add their part to this culture. With careful planning they can be made to add more. With every instructor giving the proper thought to this very important phase of our work and doing his very best in this direction, I am sure that we can and will add to the cultural phase of our engineering education. I believe that if we create in our students an intense desire to know things for the sake of knowing, and can sufficiently stimulate their intellectual curiosity, the matter of culture will be largely taken care of. After all, we must remember that we are teaching people and not things.

By E. A. HOLBROOK,

Dean, Schools of Engineering and Mines, University of Pittsburgh

A frequent subject of conversation on any university campus is culture. A certain course of study is advertised as being of cultural value, which gives the impression that courses not so talked about have zero culture. A student changes from engineering to a

general college course, because he wishes to have a cultural education. Again the impression is given that somewhere in a university there is a charmed circle of the cultured and that on the outside there is no culture.

If an engineer takes on an inquisitive frame of mind, and asks his colleagues and acquaintances about culture, he receives some surprising replies. Some believe culture is a certain ability at small talk; that culture is something nice with which you impress people by talking about it; or you have to read a new book of fiction every week in order to keep up to date and cultured. One person is tremendously interested in modern art and has no patience with another because he prefers to talk about anthropology. We all know men who teach cultural courses, whose table manners make others shiver. It is all so confusing, when one tries to define and to limit a field called culture.

Let us start with the assumption that subjects taught in an engineering school are not cultural, and return to the liberal arts courses. I go to department A. There the head tells me that one should know something of his subject in order to be cultured. Likewise in department B, I am informed that there is nothing very useful about the subject, but it is essential to a cultural education. And so in departments C and D and others, I am given the impression that their subjects are a necessary part of a general cultural education. Now no undergraduate, even in the most general four year undergraduate college course, ever takes all of these cultural subjects. Therefore, in truth no one can be cultured by means of any undergraduate program of studies. Aside from any undue emphasis I have given some of the preceding discussion, it must be true that we have used "culture" as a catch word in education, until it means something different to each of us.

In the dictionary the first meaning of culture has to do not with education, but with "cultivation, as of land." Here for the first time I grasp the true meaning of the word, not cultivation of small talk, but in plowing out of one's self the stones of prejudice, harrowing the mind with knowledge, and producing a crop, not of one special kind of vegetable, but an evenly balanced garden, out of which we try to keep the weeds.

We come then to the second definition, "Improving or developing by education and discipline." "The training, disciplining, or refining of the moral and intellectual nature." I am certain that many of us, in considering the subject, have emphasized its intellectual nature rather than its moral nature; but the dictionary places them in reverse order.

I am so bold as to say that, as an engineer, culture to me means an appreciation of several fields of science and art, and the humani-

ties, that we may enjoy talking, and thinking, and doing, and living something in them. An engineering friend feels that to him culture is knowing something of our inheritance, with as much emphasis on science as on art. To me, if an engineering senior knows a lot about electrical engineering and has an uncultivated moral sense, he is hopeless as a cultured man. Likewise, you may know and quote Shakespeare, but if you have no sense of appreciation of the application of modern science to our 20th century civilization, I likewise doubt the degree of your culture.

One of the intimate subjects I discuss with individual engineering students is culture. A boy usually brings it up by saying that one of his chums in another school feels sorry for him because he is working so hard in engineering and yet is missing something. The other boy feels that he is cultered because someone has told him that he is and, consequently, the engineering student is made to feel again, outside some charmed and closed circle. I usually remind the boy that the average four year engineering course contains around eighty credit hours of English, mathematics, science, economics, and electives, which generally are recognized by a college as being within its own liberal and cultural field. Most colleges grant the Bachelor's degree on completion of one hundred twenty (120) credit hours; therefore, the undergraduate engineering student has received, perhaps innocently, at least two-thirds of the content of an undergraduate cultural course. I tell him that if he wishes more of this work, to the exclusion of his professional engineering studies, the way is open for him to make the change to another school. I sometimes think that we engineers have been too modest in claiming some cultural value from the four years of study as now outlined in most engineering schools.

In order to learn whether our engineering boys were cultured or uncouth, as compared with other university students, I made several comparative studies as to relative numbers engaged in several cultural activities. For example, most people agree that music appreciation is an expression of culture, and I find that fifty-three out of one hundred members of the University band are engineering undergraduates. Since only about one-fourth of the University undergraduate men are registered in engineering, it follows that we have more than our share of men with musical ability and appreciation. I also defend the Reserve Officers' Training Corps as a cultural effort, especially at institutions like the University of Pittsburgh, where it is on a voluntary basis. Here I find that out of a total of sixty officers, thirty-seven are engineering upper class men.

You will agree that general reading and a liking for books and magazines is another form of culture. Recently a questionnaire to

a group of engineering students revealed a breadth (not a total quality) of books and magazines read not excelled by other students.

There is a culture evidenced by good manners. During my thirty years of contact with a variety of American and foreign college students, I cannot admit that engineering students have been more lacking in this essential than have students in other fields. To me, it is still a joy to see the frequency with which "raw" boys of eighteen develop in four years into personalities that attract favorable attention from prespective employers.

Most of all, some of those who speak glibly of culture, sometimes forget that an interest in, and an appreciation of the moral and ethical is integral to culture. A private survey made some years ago in another university revealed that a large percentage of the engineering students were frequent attendants at church or at Sunday School. At the University of Pittsburgh, I find this year, that of eighty-six undergraduate leaders in a certain religious activity, thirty-four are engineering students. Certainly if culture is related to moral development, we have another evidence of culture in our students.

Let us tell our students that they are gaining a culture in their drawing and design studies, in their English, and sciences, and electives, and engineering studies. A good book on sanitary engineering will teach me more of living successfully in the 20th century than will a knowledge of the second Punic War. Let us tell our students that they can keep up their interest in music or reading or religious work and be the better engineers for their pleasure. Let us tell them that they cannot get a complete education here at college in four years, no matter what studies they undertake. Let us believe that they are getting a culture, and that a study which may be useful, may likewise be cultural. Let us tell them that culture is not the sole possession of a handful of studies. Let us tell them that they can take engineering and be engineers, and still be within the circle of cultured people.

REPORT ON E. C. P. D. ACCREDITING FOR THE YEAR 1937–38

By H. P. HAMMOND

Dean, School of Engineering, The Pennsylvania State College

This report is submitted as an accounting to the Society by its representative on the Committee on Engineering Schools of Engineers' Council for Professional Development for the year 1937–38.

The following tables of statistics are largely self-explanatory. The first table gives the total number of curricula submitted for inspection, the number approved unconditionally, and the number not approved up to June 15, 1938. The second table gives information about particular engineering curricula. This table is for the duration of the accrediting program up to October, 1937, the last time that formal actions were taken by E. C. P. D. It will be observed that 140 institutions have applied for inspection and that virtually all of these have been visited. The first stages of the accrediting procedure are therefore almost entirely completed.

TABLE I

STATUS OF E. C. P. D. ACCREDITING PROGRAM

Curricula submitted for inspection (To June 15, 1938) 672

	No.
Acted upon by E. C. P. D.	617
Reinspected but not acted upon	23
Inspected for first time but not acted upon	14
Resubmitted but not acted upon	3
Deferred	15
	672

	No.	Per Cent
Curricula acted upon by E. C. P. D.	617	100.0
Approved unconditionally	369	59.8
Approved for limited periods	76	12.3
Not approved	172	27.9

Approximate total number of institutions in United States that confer degrees in engineering	160
Number that have applied for inspection (including 4 not yet inspected)	140
Number of institutions acted upon	129

Number having one or more approved curricula (approximately 68.1 per cent of total number of institutions) 107
Number acted upon having no curricula approved (approximately 16.3 per cent of those acted upon 21
Number deferred 1

Total number of different varieties of curricula submitted for inspection —40, of which 23 were recognized by E. C. P. D. and 17 were regarded as highly specialized and were therefore not accredited under designation submitted.

TABLE II

TOTAL NUMBER OF CURRICULA SUBMITTED IN EACH BRANCH AND THE NUMBER ACCEPTED WITHOUT RESERVATION AS OF OCTOBER 1, 1937 (LAST ANNUAL MEETING OF E.C.P.D.)

	No. acted upon	Accredited without reservation	
		No.	Per cent
Aeronautical Engineering	13	7	53.8
Agricultural Engineering	12	0	0
Architectural Engineering	16	11	68.8
Building Eng. and Const	1	1	100
Ceramic Engineering	9	5	55.6
Chemical Engineering	75	28	37.4
Civil Engineering	121	77	63.6
Communication Engineering	1	1	100
Electrical Engineering	117	76	65
Electrochemical Engineering	2	2	100
Engineering Mechanics	1	1	100
General Engineering	13	4	30.8
Geological Engineering	6	2	33.3
Industrial Engineering	25	15	60
Mechanical Engineering	112	74	66
Metallurgical Engineering	28	23	82.2
Mining Engineering	28	22	79.6
Naval Arch. and Marine Eng	3	3	100
Petroleum Engineering	10	10	100
Petroleum Refining	2	1	50
Public Health Engineering	1	1	100
Sanitary Engineering	5	4	80
Transportation Engineering	1	1	100
Others (Specialized)	15	0	0
Total	617	369	59.8

CONTINUATION OF THE ACCREDITING PROGRAM

Procedure for Maintaining the E. C. P. D. List.—It will be noted in E. C. P. D. publications that the list of accredited curricula is always referred to as "subject to continual revision." The use

of this term reflects the fact that it will be necessary at intervals to review the status of each institution and each curriculum in order to insure maintenance of an accurate listing. It is expected that this will be accomplished through two types of periodic reports. The first is to be a brief annual report to be requested by a letter addressed to the administrative head of the engineering school requesting information on significant changes and developments during the preceding year. If this inquiry discloses any conditions which seem to demand further investigation, a more thorough study will be made either through correspondence, a more complete questionnaire, or a visit of inspection.

In addition to the annual report, each institution will be asked to supply data by means of a questionnaire similar to the one employed in the original inspection. This questionnaire will be circulated at longer intervals, say from three to five years. There will also be periodic visits of inspection at intervals of five or six years, depending on circumstances. It is expected that on the average, one fifth of the institutions will be revisited each year. The national and regional accrediting committees will therefore be continued in service, but there will be adopted a plan of rotation of membership in both committees.

Advisory Services.—The national committee will stand ready at all times to supply advice or to coöperate with institutions requesting such services in relation to such circumstances as the establishment of new curricula, major changes in equipment or personnel, and important changes in educational policy. Service of this type will be given, of course, only upon request.

Problems under Consideration.—The committee has under consideration a number of problems which have arisen in the course of the first stages of the accrediting program. These include study of the general status of junior college programs and their possible accrediting; the matter of dealing with students transferring from junior colleges or from non-accredited curricula to accredited curricula; graduate work in engineering, etc. Each of these problems is being dealt with by a sub-committee of the national committee.

Financing.—In order to maintain the accrediting program it will be necessary, as in the past, to secure funds to defray overhead expenses of the central office and other general expenses, as well as to meet the cost of periodic reappraisals and reinspections. It is expected that the general plan of financing now in effect will be followed; that is, to secure support for the overhead expenses from outside sources and the direct expenses of inspections from the colleges themselves through the levying of an annual fee. This is the case with certain other accrediting agencies.

Results of the Accrediting Program

I believe I may speak for all of the members of the Main Committee on Engineering Schools by saying that none of us would seek this job.

I may also say that, in my opinion, if engineering education were free to choose, it would be better, all things considered, not to have accrediting than it would be to have it. This statement does not overlook the real benefits which an accrediting program, properly conducted, may have. It is to be recognized, however, that we are faced with the condition that if accrediting is not done by E. C. P. D. it will be done by another agency or by other agencies. It seems wise, therefore, from the standpoint of the colleges, to have this work done by an agency in which they, as well as the other divisions of the engineering profession, are represented. This is why E. C. P. D. undertook the present program and is the reason why the members of the national and regional committees are serving on them.

It is clearly evident that any program of accrediting has inherent drawbacks. The chief of these, and of fundamental importance, is the ever present danger that accrediting may produce a forced regimentation of engineering education. This is a danger of which our committee must be continually on guard. In the statement of the basis on which curricula are examined and appraised, E. C. P. D. at the beginning of this program of accrediting laid emphasis on qualitative rather than quantitative criteria. It is our purpose to maintain this principle—though it is not always easy to do so. Vigilance is required at all times to minimize the tendency to reach decisions on the basis of purely quantitative factors such as details of curricula, equipment, and the like, rather than upon major qualitative factors including the effectiveness of the teaching staff, standards of instruction, quality of students, etc. I believe it is fair to say that the committee has been reasonably successful in maintaining its original principle in this connection.

Numerous instances might be cited to indicate this, but I shall mention but one, namely the case of Harvard University. Some years ago the Harvard Engineering School discontinued its regular undergraduate curricula. At present, all undergraduate engineering instruction is offered by Harvard College in what is called "engineering sciences." Upon completion of a four-year undergraduate program in this field, the student may enter the Harvard Engineering School and pursue work for an advanced degree. Graduates of other institutions may likewise enter the Harvard Engineering School as graduate students. In the Graduate School

of Engineering there are no formal curricula in such divisions as civil or mechanical engineering, but merely groups of subjects constituting fields of concentration.

This arrangement is such that the work does not conform to the E. C. P. D. program of accrediting, which recognizes specific curricula in the major branches of engineering. At the suggestion of the authorities of Harvard University, however, E. C. P. D. gave consideration to the establishment at Harvard of special programs of courses leading, through four years of undergraduate work and a fifth year in the Harvard Engineering School, to a special form of certificate attesting the fact that the recipient has pursued a group of courses conforming to E. C. P. D. requirements and standards. These programs are made up of offerings both of the Harvard Engineering School and Harvard College and correspond closely with the customary pattern of engineering curricula. E. C. P. D. has recognized and accredited these special certificate programs.

This is an instance of an institution offering engineering work according to a plan entirely different from that of other institutions, and of the flexibility of E. C. P. D. procedures through which the quality of the work and the qualifications of the students could receive appropriate official recognition.

A second major difficulty of the E. C. P. D. program is that of maintaining a single standard throughout the entire country and for a great number and variety of curricula. In this connection it is to be noted that the recommendations of the visiting committees must first be considered and acted upon by the regional committees; the recommendations of the latter must in turn be submitted to and acted upon by the general (national) committee, which, finally, submits its recommendations to E. C. P. D. A considerable degree of uniformity is thus assured. All curricula must include the following elements as minimum essentials:

1. Sufficient work of acceptable quality in the basic sciences and humanistic studies that underlie a sound program of engineering education.
2. Work of sufficient quantity and of acceptable quality in the applied sciences group of the curriculum: analytical mechanics, strength of materials, hydraulics or fluid mechanics, thermadynamics, electric circuits, etc. The studies of this group and the relative emphasis upon each of them will vary, of course, with the particular curriculum under consideration but a substantial foundation for the later professional studies must be adequately laid in this division of the curriculum.

3. Courses of a so-called professional type, meaning those in the major field of engineering in question, of such character and quantity as will insure in the graduate a status which, from the viewpoint of the general public, would justify the appellation of engineer in the specified field.

While an accrediting process undoubtedly involves the difficulties and dangers just described, as well as others, it has become apparent in the course of the present undertaking that real benefits are also to be derived from such a procedure. In order to indicate examples from among a great many instances of such benefits, I am quoting the following two letters that were received when the first list of accredited curricula was announced. One of these is from an institution whose curricula were accredited; the other is from an institution, all of whose curricula were not accredited. They are typical of other similar communications.

LETTER NO. 1

We are naturally gratified in receiving the news of your letter of October 8 indicating that the engineering courses of ———————— College have been accredited by the E. C. P. D. Committee on Enginering Schools. We shall not rest in complacency, however, but attempt in every way to improve them. Certainly we appreciate the careful scrutiny which the Committee has given our institution and others in this investigation; it will certainly mean a great deal in forwarding engineering education in this section of the country.

LETTER NO. 2

It has occurred to me that it might be a comfort to you, in connection with your responsibilities as Chairman of the Engineers' Council for Professional Development, to know that we deeply appreciate the service which the representatives of the Council have rendered us at ————————, disappointed though we were at the findings.

Certain important members of your Visiting Committees were willing to talk freely with us and to answer our questions frankly and constructively. We feel that they were wise in their counsel and we are deeply grateful for the experiences of the past year, though the failure to accredit fully was a decided shock at the time.

We have taken their criticisms seriously and have acted vigorously in our endeavor to strengthen the engineering faculty and curricula and to improve the equipment. We have made notable progress in all three directions this past year and we owe a great deal to . . . and other members of the delegations for their wise counsel and their fine spirit of helpfulness.

A group which sets out to render a patriotic and scientific service such as your Council has undertaken necessarily creates disappointments and

arouses antagonisms and publicly receives unpleasant criticism. For this reason I thought it might do you good to know that at least one institution feels itself greatly benefitted by your work.

As a result of our four years of experience I believe I am entirely safe in saying that the net result of the accrediting process to date has been to benefit engineering education throughout the country and that the benefit has been distributed equally among the stronger and the weaker institutions.

REPORT ON TWO YEAR TERMINAL PROGRAM FOR ENGINEERING STUDENTS

In the summer of 1937 the Office of Education of the Department of Interior agreed to coöperate with the S. P. E. E. in an investigation to ascertain what, if anything, the various engineering institutions of higher learning in the United States were doing to establish a two year terminal program for engineering students.

In December, 1937, the Assistant Commissioner of Education, Miss Bess Goodykoontz, addressed to the presidents of all the Engineering Colleges in the United States the following letter and Questionnaire.

December 2, 1937

My dear Mr. President:

The Office of Education and the Society for the Promotion of Engineering Education are coöperating in a brief study of shorter-than-four-year college courses which directly affect the engineering curriculum. These courses, usually one or two years in length, may be under the direct administration of the school or college of engineering, or they may be administered by the University. In either case they are required of all prospective engineering students.

It will be greatly appreciated if you or your dean of engineering will answer the two questions on the reverse side of this sheet. A penalty envelope requiring no postage is enclosed for your use.

Sincerely yours,

(Signed) Boss Goodykoontz,
Assistant Commissioner
of Education.

QUESTIONNAIRE

Investigation of Shorter-than-four-year College Courses Related to Engineering

Does your university or your school of engineering have special or unusual arrangements under which prospective engineering students are given try-out courses, general cultural courses, or terminal courses when they first enter the institution and before they enter upon the professional engineering courses?

Yes ————. No ————.

In case of a negative reply, please send back promptly the unfilled questionaire.

In case of an affirmative reply, kindly answer the remaining questions

2. When was the program or curriculum put into effect?

Date ————————.

3. What is the number enrolled in it? ————
4. Do you give some form of certificate to a student completing it? Yes ————. No ————.
5. Please send any available catalogue, rules or regulations governing the courses, curriculum or program.

Describe briefly on a separate sheet or sheets:

6. The chief characteristics of the program.
7. Reasons given for its establishment.
8. The chief difficulties your program is meeting and how you are over coming them.

Signature and title of officer responsible for this report.

————————————

————————————

Date ————————————

But seven of these institutions answered the first question in the affirmative, indicating that they had some kind of a terminal program.

Those institutions were:

1. University of Akron.
2. Columbia University.
3. University of Florida.
4. Louisiana State University.
5. University of Maine.
6. Newark College of Engineering.
7. N. C. State College.

A summary of these replies is herewith presented. The numbers of the columns correspond to the numbers in the above questionnaire.

Name of Institution	1	2	3	4	5	6
University of Akron	Yes	1935	125	No	See Catalogue	

(8) Program too general, not enough professional work. Going to withdraw Engineers from lower, upper College plan.

Columbia University	Yes	1914	305	No		

(7) A carefully developed curricula in each of the major branches of Engineering. Give student a view of problems of modern life and relation of engineer to great economic and social questions of day.

(8) Subjects such as mathematics, physics, chemistry and economics presented in very academic, abstract form. Lack of con-

tinuity between science and engineering studies has been reduced by inter-faculty committees.

UNIVERSITY OF FLORIDA	Yes	1935	1834 Prospective engr. 325	Yes	See Catalogue

7. CHIEF CHARACTER OF PROGRAM

(*a*) A new system of admissions was placed in effect so that an attempt to give educational guidance is made upon entrance to the University.

(*b*) By means of a series of comprehensive courses an attempt is made to give a broad base for the educational program which follows.

(*c*) Only the superior student can secure the courses usually given in the first two years of an engineering college program. Students not properly prepared can not secure the basic courses to their professional curriculum until their third year.

(*d*) Comprehensive examinations are used to measure achievement, grades are not used primarily upon quantity of work done.

(*e*) Courses in sociology, economics, and biology are given to engineers in their Freshman and Sophomore years.

(*f*) An easy terminal is provided at the end of two years for students who probably should leave college at this point.

REASONS GIVEN FOR ITS ESTABLISHMENT

(*g*) Probably reduces cost of instruction in first two years.

(*a*) Student guidance pertaining to educational and vocational matters.

(*b*) A broad education for all students.

(*c*) Grading on the basis of achievement in prerequisite and foundation courses.

(*d*) Broadens the base of education for students who are preparing for study in professional fields.

CHIEF DIFFICULTIES, ETC.

(*a*) Difficulties in coördinating work of General College and of Upper Divisions have been "ironed out" by frequent conferences with faculties and Deans involved.

(*b*) Difficulties in securing proper instructors, class room facilities and carefully organized causes of study for comprehensive courses are slowly being overcome as added facilities and funds are secured by the General College.

(*c*) Difficulty is experienced in securing time and instructors for giving proper vocational and educational guidance.

Louisiana State Univ.	Yes	1932	600	No	See Catalogue

(6) Courses open to freshmen are organized into four main groups. All students take English and either Phy. Educ. or Military. Second group consists of 2 courses in social studies. Third group composed of sciences. Fourth group composed of a variety of courses either vocational or cultural designed to enable student to discover his major interests and abilities. Sophomore year students permitted to enter upon a degree program.

(7) High-school graduates have not arrived at a stage of sufficient mental maturity to have completed a desirable general education. Object of program is to complete the general education and at same time provide certain other courses planned to enable them to discover for themselves under proper guidance the abiding interests which they possess.

University of Maine	Yes	1936	33 special and 8 transfer special	No	See Catalogue

(6) Two divisions of students not carrying satisfactorily the regular curriculum in Agriculture, Arts and Science, and Technology. First division the student registered as special student in college in which he has not been doing satisfactory work. In second division, transfer specials, student is registered in college in which he has not been doing satisfactory work with a modified curriculum in the new college.

(7) Provide for students who were not carrying satisfactorily the regular curriculum in the College of Agriculture, Arts and Science, and Technology.

Newark College of Engineering	Yes	1930	365	No	See Catalogue

(6) During first two years students have no work in professional subjects. Student who has completed Junior College work may qualify for entrance into Senior College by meeting requirements of general fitness for the profession; having a good scholastic record; passing comprehensive exam. Jr. College operates under academic control of Dean and Director of Curriculum. Sr. College operates under academic control of a Department Head.

(7) Provide two year terminal course for those who for good reasons cannot or should not continue their college training beyond

Jr. College stage. Provides a division between pre-professional and professional college work as regards academic administration.

(8) In early development of Jr.-Sr. College division uncertainty regarding type and nature of comprehensive exams. that would be most suitable for these conditions. Condition being eliminated as experience increases with every new class.

N. C. State College Yes 1935 662 See Catalogue

(6) Most of the Freshman and Sophomore courses are administered and taught by the Basic Division. Freshman year is standard and same for all curricula in School of Engineering. Sophomore years are all very similar and vary in most cases by only one or two courses. In first two years students complete basic science work in Math., Physics, Chem., and take Military, Phy. Education, English and such vocational and sub-professional courses as Mech. Drawing, Surveying and Shop Work.

(7) We are part of a large University system and the faculty and courses are easier to administer under this arrangement. There seems to be no other way it can be done because the courses in the upper division or Jr. and Sr. years cannot be taught efficiently or at all satisfactorily unless the student has had the preparation required in the Basic Division.

(8) More than 50 per cent of those who begin as freshmen never complete the sophomore year. If entering students were better prepared and more capable more of them would finish. Three standard placement tests are given and these are used in advising freshmen and sophomores as to their probable chances of success with an engineering curriculum.

Total Number of Students affected by the Programs—2,423.

Interpretation of Results

The returns from this questionnaire seem to indicate quite clearly the following:

1. The vast majority of engineering institutions of higher learning in the United States do not have any definite terminal facilities for their students at the end of two years. The affirmative replies to question were only 7 in number or about 5 per cent of the institutions in the United States. The number of engineering students affected by this program is 2,423 or about 3 per cent of the total engineering enrollment.

2. With the exception of Columbia University, all of these programs were started since 1930—most of them since 1935.

3. The University of Florida is the only institution which offers a certificate for the successful completion of two years of this work.

4. The chief characteristics of the program vary with the institution. They all seem to have these objectives:

(*a*) More general education.
(*b*) Better guidance.
(*c*) An effort to find a soft easy method of eliminating those mentally or by aptitude unfit for the engineering profession instead of the severe competitive method of elimination and survival of fittest.

5. The difficulties with the program also are varied. Chiefly, they were:

(*a*) Lack of coördination.
(*b*) Lack of continuity.
(*c*) Lack of funds, instructors and facilities.
(*d*) Inability to devise comprehensive examinations suitable for use.

6. The two year terminal programs as now used in seven of our engineering institutions of higher learning have yet to demonstrate that they will produce any better engineers. In fact few of the advocates of these programs claim their systems will produce better engineers—but they do claim that all who come under their systems, including those who fail, will be better citizens. And that seems to be the crux of the movement for two year terminal facilities for engineers.

The Chairman of the Committee takes this opportunity to thank the members of the Committee and the Office of Education for their coöperation and assistance.

Committee: A. R. CULLIMORE, C. M. JANSKY,
P. R. KOLBE, B. F. BAILEY,
LOUIS O'SHAUGHNESSY, J. W. BARKER,
W. R. WOOLRICH, B. R. VAN LEER, *Chairman.*

PROFESSIONAL PHASE OF ENGINEERING EDUCATION *

By A. A. POTTER,

Dean of Engineering, Purdue University

Before discussing the professional phase of engineering education it is desirable to attempt to clarify the meaning of profession and with particular reference to engineering. To the person on the street the term "professional" is applied to anyone who plays ball for pay as contrasted with the amateur who plays games for fun. Among intellectual people a professional person is considered as one who possesses special knowledge, used by him in either guiding, advising or instructing others, or in serving the public through some fine art. A professional person is expected to be an authority or an expert in his calling, as contrasted with the amateur, who is ordinarily found to possess only a superficial or very elementary knowledge of the art or the science he practices. A profession involves public avowal, and is usually associated with the practice, application and development of a science or an art on a high intellectual plane, subordinating manual to mental dexterity.

Colonel Willard Chevalier in an address before the National Association of State Boards of Engineering Examiners on October 11, 1937, stated that professional prerequisites include: technical and intellectual fitness, a conscience that assures a responsibility to the community for the standard of performance, proper mental attitude and licensing to protect the public from the incompetent. Colonel Chevalier emphasized that "there is something bigger, more vital and more fundamental in professional relationship than anything you can write in a statute."

Abraham Flexner stated that "professions involve essentially intellectual operation with large individual responsibility. They derive their raw materials from science and learning. This material they work up to a practical and definite end. They possess an educational communicable technique. They tend to self-organization. They are becoming increasingly altruistic in motivation."

Dr. W. E. Wickenden in several of his addresses and papers (ENGINEERING EDUCATION, Vol. 15, and Final Report S. P. E. E.,

* Presented at the 46th Annual Meeting, S. P. E. E., A. & M. College of Texas, June 27–30, 1938.

Survey of Engineering Education) places the attributes of a profession as:

1. A body of knowledge (science) and art (skill) held as a common possession and to be extended by united effort;

2. An educational process of professional aims, which implies a constructive share by the professional group in the ordering of education;

3. A standard of qualifications for admission to the professional group, based on character, training and competency;

4. A standard of conduct in relation to clients, colleagues and the public, based on courtesy, honor and ethics;

5. A recognition of status by colleagues and by organized society, as a basis of good standing;

6. An organization of the professional group based primarily on common interest and social duty, rather than economic monopoly.

The engineer, as a professional man, in addition to his scientific knowledge and technical skill, which he must be constantly improving by study and practice, is expected to have a conscious group feeling and a sense of pride in his work, an interest in improving and in extending engineering practice and standards through his engineering society affiliations, a sense of responsibility for the welfare and effectiveness of the members of his profession, and definite moral obligations for public good. The professional man must at all times place above his own rewards the best interests of Society and his personal obligations to his fellows in the profession.

The above attributes for professional status should lead us to impress upon our students the following:

1. That it is more serious for an engineer to be lacking in honesty and courage or to violate the code of ethics of his profession than it is for him to be found wanting in technical competence or in scientific knowledge. If it is our wish that books like the "Citadel" by Cronin or like those of Sinclair Lewis should not be written about the engineer, we must make certain that our students realize that the moral obligations of our profession require the engineer to possess high qualities of character. It is our duty to familiarize our students with the Codes of Ethics of the Founder Engineering Societies.

2. That the engineer's future is most intimately related to Government. Government is an essential part of our existence and is today of special interest to the engineer, as its functions are becoming largely technological in character. The future careers of our students will be greatly affected by the kind of government existing in our country. It is our obligation to society to interest our students in our government and in public questions. Good

citizenship transcends in its importance even expertness in one's profession, as the contributions which the engineer makes to society may be lost without a stable government.

3. That the engineer, who is interested in qualifying for the higher places in our profession, must have a thorough scientific preparation. As Dr. Wickenden has so well stated in his address before the A. A. A. S. in December, 1937: "Science can live without technology, but its resources are immensely enriched and its activities stimulated by the union of the two. Technology, however, can scarcely exist without the fertilizing principle of science." We should encourage our superior undergraduates to elect advanced courses in physics, mathematics and chemistry, as the achievements of our profession can only be kept at a high level by more scientific knowledge on the part of the engineer. The more gifted of our students should be encouraged to pursue graduate study with emphasis upon science. The average engineering students may do well to stop their formal education with the bachelor's degree, but even such students should be impressed, while they are at college, with the fact that their position in life and their standing in their profession will be greatly influenced by their habits of study and reading, by their breadth of knowledge and by their general culture. At the same time we must not overlook that the type of person who is attracted to engineering is more interested in the world of action than in the world of thought.

4. In order that our students may develop a conscious group feeling and an interest in the engineering profession they should be familiarized with the organizations which have been set up by engineers for forwarding our profession and for improving engineering practice. They should be impressed with the fact that the engineering societies have made it possible for our profession to have a body of knowledge in common possession by engineers, and that this knowledge is being constantly extended through the contributions of engineers to the publications of national, state and local engineering societies and clubs. The objectives of the founder engineering society group should be known to our students, who should be encouraged to take an active part as undergraduates in student branches of such societies and to affiliate themselves immediately after graduation with the founder society of their speciality. The eight functional instrumentalities, which have been set up by our profession to promote mutual abjectives, should be explained; these include the United Engineering Trustees, the Engineering Foundation, the Division of Engineering of the National Research Council, the American Standards Association, the Engineering Societies Library, the Engineering Employment Service, the American Engineering Council and the Engineers Council

for Professional Development. The student should know something about the specialized engineering societies which are supplementing the major national engineering organizations, and of the existence of state and local engineering groups to serve the engineer.

5. The engineering student should be informed that state registration for engineers is becoming more and more an index of engineering competency as it is a necessary prerequisite of medicine and of law. He should know of the National Association of State Boards of Engineering Examiners, which is an important factor in giving national scope to the licencing laws for engineers.

6. The student should be given assistance in becoming acquainted with industrial working conditions, tendencies in labor organization and legislation and with the importance of adaptability and cooperation in modern industry. A person who is interested mainly in his own work, and lacks adaptability or cooperative ability is bound to fail.

7. The student should be encouraged to develop an interest in the social trends and economic forces which affect our civilization, as the ultimate yard-stick by which our contributions are judged is the degree of well being our profession bestows upon the public at large. At the same time he should be impressed by the fact that the most successful people are those who can adjust themselves to live most happily in the social order in which they find themselves, and that the most useful people are those who serve and improve rather than condemn the instruments of our government and of our civilization.

With reference to the professional phase of our engineering programs of study there is still a tendency to magnify the differences between civil, electrical, mechanical, chemical and other branches of our profession. As early as 1893 E. B. Coxe, in his presidential address before the American Society of Mechanical Engineers deplored this tendency in the following words: "The position which the successful engineer occupies does not depend upon whether he graduated as a C.E., E.E., M.E., etc., but upon the fact that he has a mind and has had a training which has enabled him to develop in a particular direction." L. W. Morrow, formerly editor of the Electrical World, has more recently stated: "Do not specialize in terms of field divisions of engineering, but require all students to take the same fundamental course with a few electives in specialized theory, instead of specialized practice." It is time for us to realize that the work of our graduates in practice is organized largely along the functional lines of design, research, production, operation and sales, rather than in the fields of demarcation followed by our founder engineering societies and engineering college curricula.

Gano Dunn, Past President of the A. I. E. E., in his commencement address at M. I. T., in June, 1937, stated that "even the grand divisions of the engineering profession represented by the national societies of civil, mining, mechanical, electrical and chemical engineers, give little more than a hint as to occupation," not only because of the diversity of the engineer's occupation but also on account of the rapidity with which change of subject matter has taken place. Dr. Dunn concludes that the engineer's work is differentiated from that of other professions not by what the engineer does, but how he does it; "not what the engineer's occupation is, but the intellectual processes by which he attacks that occupation." The method of engineers rather than their occupation is the characteristic of the engineering profession. While the subject matter of engineering unquestionably will continue to change in the future, not so with the method of engineering—it is the method of science—that process of reasoning based upon observed data and working hypothesis. Undoubtedly there is still a need for modifications in our engineering curricula so that the young engineer may have a better knowledge of the engineering method and a keener appreciation of the problems which confront all engineers.

Numerous statistical studies lead to the conclusion that engineering education is the best preparation for executive responsibilities. In the past the engineering curricula, other than mechanical engineering, have given too little attention to instruction in management and industrial relations. Those responsible for engineering curricula are handicapping their students if they do not include some instruction which will prove helpful to their students in organizing and directing the efforts of others.

American industry has become aware of the value of art in industry; the idea of beauty is being indoctrinated in all types of devices which are the creations of the engineer. Design courses in engineering programs of study should give the student an appreciation of the aesthetic as well as the useful and efficient.

We must always keep in mind the words of Herbert Spencer that "to prepare for complete living is the function which education has to discharge." These words apply as well to the professional phase of engineering education.

By W. R. WOOLRICH

Dean, College of Engineering, The University of Texas

The Heritage of the Engineer

Two distinctive epochs in the evolution of engineering are: (1) the period of its birth during the medieval centuries as a

skilled technology through the union of the pure physical sciences and practical military mechanics and (2) the present period of its expansion from a technical science and art to a recognized profession of scientific and cultural attainment.

Probably no one man of the medieval period is more symbolical of its emergence to a useful art and scientific technique than Leonardo DeVinci. Unorthodox, he stands out as an engineer, scientist, architect, sculptor and painter of no mean abilities in all callings. After him no more could science be just the plaything of mathematicians but it would take its place in world development and reconstruction. Henceforth, science must work for mankind with the same fidelity as mankind had worked for science.

While from the dawn of history "engineers" had been employed as directors of war defenses and machines, their function was primarily that of a mechanic. By the fourteenth century England had developed its Corps of Engineers with headquarters in the Tower of London. By this period, the engineer had become the guiding genius of war machines, military highways, naval construction and national fortifications.

By the opening of the nineteenth century there had developed a demand for men of military engineering training who had been educated in the physical sciences to apply their scientific methods to peaceful occupations in making surveys of land, in laying out streets, roads and canals. Thus, we witness the first sub-division of engineering—military and civil.

Thomas Tredgold in 1820 helped organize the Institution of Civil Engineers in England. He proceeded to define engineering in terms that remained unchallenged for virtually a century as the "art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and for internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange and in the construction of ports, harbors, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns."

During the next century, the accelerated growth and acceptance of engineering activities throughout the civilized nations was unprecedented. More technical advancement was made than during any two thousand years in known history.

During this period there sprung up a large number of new professional engineering designations. This was the natural result of a rapid expansion. During this expansion period any group could

launch out under a new classification with reasonable assurance and confidence in the success of their venture.

A natural consequence of this undirected multiplication of technical branches was a rising jealousy between engineering groups that represented overlapping activities. Associated with this was a growing false philosophy sponsored too often by pecuniary interests that young men should specialize.

It was fortunate that at this juncture there was organized the Engineers' Council for Professional Development. It was the fruition of a natural growth and rising professional consciousness of a maturing engineering profession.

Thus, during its cultivated life, engineering has grown up through an early period of purely military accomplishment followed by a season of useful technical skills and emerged from a disastrous war and an economic depression to a realization that it must take its place in the great professional and administrative agencies of world development and organization; technical—political—and economic.

Henceforth, engineers, as commanders of their own profession, were to define and direct the forces of guidance, education, training and recognition through their own established agencies and with the supplementary official aid of the several states of the nation.

The Parallel Heritage of the Social Scientist

The history of the social sciences extends much further back into antiquity than does the work of the engineer. In the early history of the civilized races much of the work and activity that is now classified under this branch of scientific endeavor, if a science it is, was the responsibility of the priest and law-givers. For centuries under the Mosaic Code, religion, law and social betterment were predominantly a priestly function. Not until the Christian Era did there evolve a division between the affairs of Church and State.

Even the cultural arts were very closely woven into the religions of the day. This is exemplified in such civilizations as the Assyrian and the Grecian.

As civilization progressed through the ages, culture guarded itself against an invasion of the commonplace. The word "practical" was considered by almost all of the defenders of culture as being synonymous with the common and the crude.

By 1900 there were many evidences in the American life that some brave souls of our social sciences were ready to bring their theories and their pronouncements out of the laboratories and give them practical tests in the laboratory of life. The World War

was probably the most influential instrument in bringing many of the theories and hypothesis of the social sciences out into practical demonstrations.

The present Administration in Washington gave a great emphasis to the work of the social sciences. One of the first moves of the present incumbent of our national presidency was to call together, from the four corners of the United States, social scientists of recognized capabilities.

As was expressed by one of the leaders of this conference the President was kind enough not to press them for an immediate panacea for the predicament in which the nation found itself.

But there was created a National Resources Board. This Board was preëminently of a social science personnel. The President performed a distinctive service to the social sciences in bringing their leaders together and requesting them to define and to propagate the several theories and hypotheses on which they could agree.

The emerging social sciences have not been able to keep pace with the physical sciences in new development and methods of production. To-day the physical sciences are fully a quarter of a century ahead of the social sciences.

The Engineer and the Social Sciences

While some of our national leaders have advocated that the physical sciences should be shackled for a period to give civilization time to catch up with the procession, it is a question whether the physical sciences will ever be shackled. However, the physical scientist is going to find it necessary to enlarge his vision and take unto himself the projection of the principles of sociology and economics in those problems in which his work affects our national life and well being.

Some years ago there was developed the idea of the human engineer. The original conception of a human engineer was one who would study and interpret the principles of personnel management. But that conception must be greatly enlarged. It must include the research and investigation into the many ramifications of our industrial and national life including the international economic forces that are affecting the lives and stability of human beings.

The question might arise whether the engineer has sufficient cultural background to project himself into the realms beyond the purely scientific.

I would call your attention to the recently issued charts prepared by Dr. W. S. Learned and others of the Carnegie Founda-

tion covering a study of several years of the many college students of the state of Pennsylvania. This study was an attempt to measure the cultural attainments of the students from the several professional and cultural schools of that State.

To the great surprise of many educators from the purely cultural branches, when the winnowing was all completed and compiled, the engineering students of Pennsylvania stood up at the top alongside of the Colleges of Liberal Arts of that State. The Colleges of Pure Science, Business Administration, Education were all at a much lower level.

In reviewing this study many engineering teachers were as greatly surprised as the other educators. The background of engineering training has been heavily saturated with trade training during the past sixty years.

It is really a remarkable situation that three score years later the engineering colleges have proved themselves near the top in cultural attainment, when so many of our major engineering institutions started out with a trade and not a professional heritage.

One of the most significant contributions each engineer and engineering educator can make to his profession for the next half century is to raise the public appreciation of its highly cultural as well as its highly professional characteristics. The other professions will not appraise us one whit higher than the profession appraises itself.

Specifically, modern engineering is so far ahead in the procession that the engineer must weave into his professional activity, sociological and economic thinking, otherwise, he will continue to drive forward, upsetting the stability of human lives by his new devices that are far in the lead of the social control factors essential to the needed stability.

Civilization cannot expect the engineer to hold back his activities, but it might well demand of him that he help develop the social controls that will make new invention a blessing instead of a curse to the existing and future generation. This is no criticism of the past educational program of engineers.

When we pause in retrospection, it would seem that we are too prone to criticize the training offered by early established engineering colleges as being "too practical" and lacking cultural and sociological education. The evidence indicates that the engineering education of these early days was most fitting for the needs of the period. From 1880 to 1910 America was building frontier territory, inventing new production machines and increasing her man hour productivity at unprecedented rates. It was not the higher refinements of technical and cultural education that were most essential to this stage of development of a frontier nation.

During such an expansion period, the engineer who possessed a training in the higher mathematical and physical sciences of engineering might have been endured but not greatly appreciated outside of college halls. History indicates that stormy Elijahs pave the way for cultural diplomatic Elishas. Likewise, the rugged practical type of engineer was a fitting forerunner to the more cultural professional engineer emerging on to-day's horizon.

And in our appraisal of the needs of to-day we must recognize that America still possesses much of its frontier philosophy, especially in the rural and newer regions. In the more highly developed industrial areas of the North and East, scientific and cultural training of a high order is more essential than in the South and mid-western areas.

However, by the time the present generation of students have reached mid-life the industrial contours of American life will have changed sufficiently to demand men of more scientific and cultural bearing throughout the entire United States. On this assumption it would seem essential that our engineering colleges very generally offer more of the fundamental sciences and humanities in their curricula, but they should not overlook the fact that many of our graduates must still find their way as rugged technicians advancing America's frontier construction and development.

There are still many places where the engineer must function as a general practitioner and not as a technical scientist. In our enthusiasm to elevate our profession to a higher plane we must not overlook the true function of engineering education—to educate men as engineers and not as pure scientists.

The speaker looks with much disfavor upon the pressure from many Liberal Arts and Educational groups to define for the engineering profession what it needs in culture. The engineer with his analytical mind is better prepared to make the diagnosis and prescribe the adjustments than many of those who are steeped in much medievalism but have limited knowledge of current affairs, or who have been trained in countless hours of educational methods but lack fundamental scientific understanding.

A Suggested Program to Support Adequately the Leadership of Professional Engineers with Advanced Scientific Education

In setting up a comprehensive program for professional engineering education some suggested steps are offered for the preparation of better engineers.

(1) For the engineering profession to offer coöperative and aggressive assistance in the formulation of secondary and high

school curricula in each state and refuse to accept for college credit, courses that belong back in the high school. It is becoming more and more important to engineering education that we raise the admission standards of English, mathematics and the physical sciences by some acceptable procedure.

(2) Provide a terminal program for men who are not capable of carrying on satisfactorily beyond the freshman or sophomore year.

At the present time we have an inadequate number of well trained tradesmen and mechanics to serve as top sergeants in our power and industrial developments.

The writer would recommend that more attention be given to the sixty or seventy-five per cent that we turn aside in the educational process leading to the bachelor's degree in engineering. At least forty per cent of these men could effectively pursue a terminal course as tradesmen and mechanics and provide a reservoir of mechanics and artisans to help fill the gap brought about (*a*) by the decrease in migration of able mechanics from Europe and (*b*) by the breakdown of the American apprenticeship system.

More specifically we should set up in every region, where they do not already exist, one or more training centers where high grade mechanics can be trained. Until this is done there will be a decided tendency to draft engineering college graduates into this field.

In the College of Engineering of The University of Texas, men who do not have a C average are not permitted to take any junior work. We are encouraging more and more of these men, who might have manipulative skill, to turn to the technical trades. At least one junior college within the State of Texas is making it possible for these men to readjust themselves by taking terminal trade courses in electricity, in machine shop operation and in aeronautical repair and maintenance.

Of the more than 80,000 who are in engineering colleges this year it can be conservatively estimated that not more than 30,000 will ever receive degrees. Of the 50,000 who will drop by the wayside, at least 20,000 should be adaptable to trade training.

(3) Reduce the specialized or "things" courses in the requirements for the Bachelor's Degree and build up a strong minimum requirement in engineering mathematics, mechanics, thermodynamics, electrics, hydraulic design and well selected non-technical electives in economics, sociology, literature, history and art. One reason why we are having so much difficulty preparing for the bachelor's degree in four years is that we are giving too much high school instruction in the freshman year of the course and attempt-

ing to give too much specialized work that belongs on the graduate level to the senior students.

The awarding of the bachelor's degree should be the natural stopping point for a large group of men in formal college education. If they have earned their degrees by very narrow margins, it would seem inadvisable for them to attempt to build up a graduate year, requiring in most universities a B minimum grade, upon an undergraduate grade structure that is lower than B.

In industry these low scholarship men will serve as capable general practitioners but with a few exceptions will not progress rapidly into the more advanced types of professional engineering.

By eliminating the mediocre men by the end of the fourth college year, it will permit the faculties of our engineering colleges to give the advanced work to selected men in the fifth or graduate degree year without the handicap or expense of carrying along the "random run" type of engineering student beyond his baccalaureate degree.

Especially, from the standpoint of the state supported universities and colleges, would this program seem most rational and desirable. The trade training supplement would offer us a method of conserving and salvaging the education of those who cannot master the engineering sciences beyond the second year. The requirement of a B average to proceed in graduate study would afford the State relief from financing advanced training for men who do not have a background to justify their going into the higher refinements of the mathematical and physical sciences. It would permit the faculties to direct their efforts, and the state to expend their funds, in educating the best men for the higher scientific and professional positions.

(4) Provide graduate short courses or conferences for men who have degrees but who would like to return to the university or college halls for a short period at intervals to keep up with the progress in specialized fields.

The essential elements of this program will involve more activity on the part of the engineering educators in the national, state and community life of to-day.

In the affairs of our national educational program at Washington, engineers are notably absent. On the National Resources Board, engineers are but little represented. In our state departments of education and state educational societies the engineers usually lack interest and often even a coöperative spirit. In the smaller political units they give no voice.

These agencies that are preparing the plans and influencing the governing bodies by which our profession is greatly influenced are for the most part graduates of Colleges of Education. We need

more engineering educators actively participating in strategic civic and governmental affairs.

One of the needs of the profession is more universities and colleges who will educate engineering scholars and leaders. And from amongst these engineering scholars and leaders should spring national statesmen who will take a more active part in the legislative and administrative affairs of the state and nation.

Ours is a heritage that embraces the conservation, the creation and the direction of men and machines for the welfare of mankind. And in accepting this responsibility, statesmanship and sacrificial consecration to the task is an essential attribute.

May we hasten the day when the engineering college of every campus is viewed with due reverence by the other professions because of its high standard of the cultural and of the scientific and for the recognized professional ethics and accomplishments of its graduates and faculty.

By PARKER H. DAGGETT

Dean, College of Engineering, Rutgers University

Any discussion of the professional aspects of engineering education must necessarily revert to the investigation of engineering education conducted by this Society under its Board of Investigation and Coordination. The final report of the Director of Investigations summarized a discussion of this subject in the following words. "It is the view that the normal type of undergraduate course in engineering is of a broadly functional character of equal value in itself and as a foundation for much more explicit professional training; that this type needs to be guarded from encroachment of a vocational or 'ad hoc' type of training, either for particular technical callings or for particular industries; that while it is neither possible nor desirable to restrict engineering education to a professional discipline, it would be equally undesirable to lose its present professional orientation; and that the highest type of professional education may ensue as graduate work in those engineering schools which maintain the fullest professional standards." *

At the time of the investigation you will recall that there was a fairly strong demand for a more strictly professional objective. Not a few argued that four years of formal training was not sufficient time in which to reach this objective, and that our curricula should therefore be lengthened to five or even six years. From a strictly professional standpoint this thesis is not difficult to defend.

* Report of the Investigation of Engineering Education, Vol. II, p. 1089.

On the other hand, what Director Wickenden called "the functional character of engineering education at the undergraduate level" has been pretty generally accepted as the norm. Thus we are obliged to mould our curricula with a two-fold aim in view. We must provide a training which will be useful alike to those who are destined to become professional engineers, in the narrow and legal sense of the word, and those who can best serve society by undergoing such training even though they may never become professional engineers.

A large majority of the students who successfully complete the rigorous training of our schools must inevitably pass on into a life-work in which the specific technical knowledge which they have acquired may be only of incidental value. For that fact we need offer no apologies if we place the greatest good to society above the narrower aim of service to the profession. The important consideration for this group is not that they have acquired a considerable body of knowledge for which they have no use, but that they have been trained to solve problems in the same manner as the professional engineer; not that they have started out to become professional engineers and ended in some radically different life work, but that they have been trained to think, to analyze, to weigh one scheme against another, and to develop their creative imagination by practice in design. Society has need for men of this type, and if the engineering schools are capable of turning out such men, then society has a right to expect the schools to supply them.

Can the engineering schools do this job and at the same time care for the legitimate needs of the engineering profession? The answer is, yes. We are doing it, and have been doing it for years.

What are the legitimate needs of the engineering profession? What is a professional engineer? According to the "Model Law for the Registration of Professional Engineers" the term means—

> "a person who is qualified by reason of his knowledge of mathematics, the physical sciences, and the principles of engineering, acquired by professional education and experience, to engage in the practice of professional engineering."

Professional engineering is defined to include—

> "any professional service, such as consultation, investigation, evaluation, planning, design, or responsible supervision of construction, or operation, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects, wherein the public welfare, or the safeguarding of life, health or property is concerned or involved, when such professional service requires the application of engineering principles and data."

I have given these quotations from the Model Law because these definitions, or definitions with closely similar wording, appear in the Engineering Registration Laws of three-quarters of all the states in the union. In these states they are the only legal definitions. Under these laws it is the duty of all duly constituted officers of the state, or of its political subdivisions, to prosecute a person who, without being duly licensed by the state registration board, practices, offers to practice, or who dares so much as to "use in connection with his name or otherwise assume, use, or advertise any title or description tending to convey the impression that he is a professional engineer."

In discussing the professional phase of engineering education this fact must be kept in mind. *The only gateway for admission to the engineering profession in the states which have comprehensive registration laws is by proper certification by the state boards.* This fact is not as generally recognized as it should be by the general public, or even by engineers themselves. It has been recognized by groups of engineers in some twenty states. Eighteen of these twenty states have licensing laws under which some 34,000 professional engineers have been licensed.* In each of these twenty states a State Society of Professional Engineers has been organized under charters granted by the National Society of Professional Engineers.

The following quotations illustrate the type of thinking, about engineering and engineering education, that is going on in the minds of those to whom the legalistic aspect of the question is the all important consideration. The first, from the handbook issued by the largest of these state societies, is significant: "The only agency that can admit a man into the Engineering Profession is the legally authorized State Board. Membership in an Engineering Society does not make a man an Engineer. He should be an Engineer before he is admitted to membership. The National Society of Professional Engineers is the only organization in which all the members are Engineers."

At the last convention of the National Society one of the speakers remarked from the floor—"I think that one of the objects of our society should be that of furthering the proper education of engineers, to take charge ultimately of engineering education in the United States to the extent that the Medical Association has taken charge of the supervision of medical institutions in this country. It is one of the finest objectives that we could possibly have. . . ." To which the president of the society replied—"I might say that these recommendations are fairly well advanced in the councils of the society. . . . We hope that the time is not far distant when

* All but 8 states now have licensing laws for engineers.

there will be established such standards for entrance into the profession as will make it possible to ascertain who has the best chance and also what the institutions of learning should teach."

The National Society of Professional Engineers is a logical and significant outgrowth of the Engineering Registration Laws. At the present time it constitutes a small but vociferous minority of licensed engineers in less than one half of the states which have licensing laws. The avowed objective of the society is to make engineering a definitely closed profession. Whether this can be accomplished solely through the indisputable power of the licensing laws, time alone can tell.

If engineering is to become a closed profession, then it is only logical that engineering education should abandon its present dual objective. Engineering schools will exist solely for the purpose of supplying the necessary recruits for the profession. The curriculum will be one of five or six years; the number of schools needed to supply the demand perhaps not more than half the present number; and the cost to the individual and to society for the necessary educational foundation very materially increased.

Whether this is a desirable step or not depends on whether society will be better served in the end, not on the probable benefits to the individuals who have a proprietary interest in the profession. For one of the fundamental characteristics of a profession as distinct from a mere vocation is the social responsibility of the former. Society naturally will benefit, economically as well as socially, if the engineering profession, on which it must depend to maintain and to advance its civilization, possesses a wider and more profound understanding of the principles that underlie the profession, and a better appreciation of economic and social needs. A longer and more thorough professional education obviously should lead to such a result.

With the engineering schools thus strictly professionalized, the legitimate needs of the majority of students now in our schools might still be supplied by curricula not far different from the present. These might properly be administered either in a college of arts and sciences or in a school of applied science. The engineering designation, however, would be reserved exclusively for the strictly professional school.

For the present, at any rate, we are committed to a four-year program which must combine professional preparation with a broader and more generally utilitarian aim. The highest type of professional service demands that this program be supplemented by an additional period of formal study in a graduate school, by part-time study under the discipleship of a properly qualified professional engineer, or in more formal evening courses in our engi-

neering schools. Many of the engineering schools in the larger centers of population have been awake to the possibility and the need of this phase of engineering education. Much more can, and should be done.

From a purely professional point of view the undergraduate training should be guided by the following considerations:

1. There should be a proper balance between the cultural and humanistic subjects, the engineering sciences, and the professional courses.

2. There should be only a limited amount of specialization.

3. Emphasis in professional subjects should be on the application of the basic principles of the engineering sciences, rather than on pouring into the student the maximum possible amount of information, much of which will be out of date before he is ready for professional recognition.

The question of balance is one that is not susceptible to rigid definition. If we consider the basic courses in the physical sciences, and in some curricula the biological sciences as well, to be cultural courses, as indeed they would be in any liberal arts curriculum, then a reasonable balance would be, roughly, one-third cultural, one-third engineering sciences, and one-third professional courses. In the cultural group the amount of English will depend on the quality of the preparation which the students have received in high schools. Formal work in general economics is usually considered today to be an essential. Some schools consider history, psychology and the like to be essentials. In others provision is made for these through electives. In the basic engineering sciences we should expect to find engineering drawing and descriptive geometry, engineering mechanics, strength of materials, surveying, and hydraulics or a more general course in fluid mechanics.

A limited amount of specialization is desirable if for no other reason than that of motivation. An additional factor, however, is the fact that in many states the laws require registration in separate branches of engineering, and even in states which have more recently passed laws, where the license is granted as a "professional engineer" without designation of field, the State Boards require the applicant to choose one branch of engineering for special examination. It is possible to work out adequate and satisfactory curricula in at least three of the major branches, civil, electrical and mechanical engineering, in which two-thirds or more of the work will consist of a core common to all.

The greatest weakness in many institutions lies in the professional courses. This is a glaring defect particularly in many of the specialized curricula that are offered. The distinguishing

feature of a professional course is, or should be, that it is built on the basic engineering sciences which must precede it, and the emphasis in the course should be on a most thorough analysis of these principles as applied to fundamental practical problems. This naturally places these courses in the senior year, although a start should be made in most cases in the junior year. All too often, however, we find senior courses which are hardly more than informational potpourris. Some are actually of the trade school type. It can scarcely be called professional training to take a fairly simple piece of equipment apart, put it together again, make a sketch of it, and then write a brief descriptive report on it.

Where such a situation exists, the fundamental philosophy of the school is often at fault. In some fields, however, we can place the blame, in part at least, on a lack of the proper kind of textbooks. We need texts in which the functional idea is carried out to the fullest possible extent, rather than more books with elaborate descriptions of this or that machine, profusely illustrated, and filled with information that can be obtained more easily, more interestingly, and more effectively from manufacturer's bulletins. We have some splendid texts for the courses in engineering sciences. How many really satisfactory texts are there, for example, in the field of alternating current machinery?

Professional courses should train the student to think, to analyze, and to develop his creative imagination by practice in design. Unless they do this they are vocational rather than professional in character.

Finally, it is an essential part of our job to give our students some insight into the professional life which awaits them. This is not an easy matter. The present status of the engineering profession is somewhat confusing. For years engineers have struggled for more adequate professional recognition on the part of the general public. On the one hand they have been damned almost with faint praise for their greatest works, while on the other hand they have been blamed for the economic debacle which has followed the unintelligent use of these works. They have stood by while the honored name of "engineer" has been applied to almost every field of human endeavor from the vocational trade of a plumber to the field of a social worker. They have developed their organized professional life through the media of separate professional societies for each individual branch, rather than a single unified organization like the American Medical Association or the American Bar Association.

The professional status of most engineers today is entirely different from that of the doctor or the lawyer. In the first place, by the very nature of his work, even as a private practitioner, he

inevitably must serve large corporate groups for the most part, rather than individual citizens. In the second place, the great majority of engineers today are, and always will be, employees of these corporate groups. They must, therefore, be resigned to seeing their individual efforts synthesized in the conglomerate product, while the individual lawyer receives credit for winning a case, the physician for saving a life.

Increased professional recognition will come only as fast, and insofar as it is merited by professional development. Even though the engineer is destined to be more submerged in the economic group, he can still conserve and develop his professional identity. By preparing himself for a better and more profound understanding of the underlying principles of his profession, for a better appreciation of the civilization he is building, and by developing and exercising whatever innate qualities of leadership he may possess, then, and only then, can he be assured of a larger place in "this sorry scheme of things."

By O. W. ESHBACH

American Tel. & Tel. Co.

An Industrial Viewpoint

A characteristic of personal conduct in professional endeavor is the act of doing good in the sense of all that the word "good" implies. To the missionary John Wesley is credited the following exhortation "On Doing Good."

Do all the Good you can
By all the means you can
In all the ways you can
In all the places you can
At all the times you can
To all the people you can
As long as ever you can.

But it remained for a colored preacher to express in a vivid sentence a philosophy or attitude of broad application. Epitomizing Wesley's thought he wrote on the blackboard at a revival meeting.

Do the *best* you can
With what you have
Where you are—*today*.

The explanation of the efficiency and effectiveness of many of the different approaches to engineering education is summed up by this simple statement.

Whatever the expectation in the application of new thought implied in the presentation of symposiums such as this, the net result will be doing the best you can with what you have, where you are to-day.

Through recent emphasis placed on the word "professional" and current activities of engineering bodies, the idea is frequently expressed that a narrow concept of engineering as a profession is likely to result and be accompanied by an orthodox or standard undergraduate procedure. I hope sincerely future history will show that this is far from the truth. The forces which will probably be most dominant in gradually affecting and shaping the character of engineering education will be first, the desire to do a good job in taking what comes to you and shaping it to fit the requirements of the environment in which you are, second, an idealistic concept of the social purposes served by the application of technical knowledge, and third, the consciousness that individual development of personal qualities of which character and idealism are among the most important, is a vital part of any educational program.

To be specific, the services as developed by the Polytechnic Institute of Brooklyn in the metropolitan area of New York and those developed by the A. & M. College of Texas, are not interchangeable except in certain fundamentals which are universally recognized and characteristic of all technical education. Second, the day is past when any large number of graduates can expect to go from school to industrial life and immediately apply a certain technique which they have learned, regardless of the environment in which they are, the individuals with whom they have to work and the ultimate purposes of the project in which they are engaged. Third, no profession can expect to be held high in public esteem unless the highest qualities of manhood characterize its personnel.

Engineering education has been regarded as a bread winner but what educational program has not? There is a difference, however, in the public viewpoint which does not depend so much on the presence of vocational aspects as it does upon the expectancy of attitudes and ideals that accompany and characterize the actions of different educational or social groups. The question, what is a profession or in other words, just what are we talking about is a natural sequel. That there is a didactic problem in establishing professional consciousness is evident.

The use of words is most carefully guarded in the legal profession yet Justice Holmes has been quoted in one of his decisions

as saying, "A word is not a crystal, transparent and unchanging; it is the skin of a living thought and may vary greatly in color and content according to the circumstances and time in which it is used." The content of the words "professional engineering" imply the following of a calling or vocation in the art of applying physical truths to the establishment of social conveniences, and the profession itself is the body of individuals so engaged. To restrict its meaning so as to apply to special acts may give it legal significance or technical meaning to a special group but it does not change the popular or genetic sense.

It must be recognized, however, that legal phases of the profession are implicit in it and any acts jeopardizing life and health should be engaged in only by legally authorized persons. As affecting educational procedure there are important aspects of the legal phases. Part of the evidence of competence is based on the quality and content of formal instruction and a professional school may not neglect training vital to public protection.

In discussing other professional phases of engineering education more emphasis may well be placed on the color as distinguished from the content of the words. Taking a personal rather than a legal view of a profession it might well be defined as follows:

Any occupation is a profession which, in affecting the general welfare, has as a necessary prerequisite to skill a common body of knowledge requiring extended concentrated education and training and employs people held high in public respect, who put service before personal gain, who are actively conscious of their social obligations, who adhere to a written or unwritten code of ethics, who consider their work as involving life long study, and who are willing to make sacrifice for the advancement of their field of activity and the individuals in it.

The thoughts here expressed are worthy of further analysis as they apply to engineering education.

Industrial Aspects of Professional Engineering

It is apparent that engineering education in the present era is the most suitable preparation for industrial life and as such should be based upon broad concepts of the social purposes which it serves. The fact that different concepts exist would seem to justify differences in objectives and curricula. In an article "Industry Demands on Engineering Education" (*Electrical Engineering*, Vol. 53, 1934, p. 518), L. W. W. Morrow suggests the establishment of two types of curricula as a part answer.

"1. A course for the mass of students that is based upon a broad education developed largely from science, engineering and

economics and taught by teachers using engineering methods and having both business and engineering knowledge, so as to train men to staff and operate mechanized industry.

"2. A course with very high standards in science and engineering to be taught by scientific and engineering specialists to be given a selected number of students so as to train men to supply the specialized technical needs of industry—the future professional engineers."

In considering a program such as this, it might also be advisable to raise the question as to whether the two courses should be given concurrently or sequentially.

Industry has a stake in engineering education. While it would be wrong to emphasize unduly the service function of the engineering schools in filling industrial needs for technical and leadership talent, nevertheless the hopes and ambitions of most of the boys who choose engineering careers are related to the objectives sought by the schools and the profession. Industry needs both types. Highly professional education is prerequisite to the expectancy of further future development of new products and methods. More diversified preparation is vital to the operation and management of industry in which necessary occupations are difficult or impossible to correlate with the professional divisions of engineering education as they now exist. Nevertheless, these activities require a knowledge of engineering facts and understanding of the fundamental laws underlying applied science.

In the report "A Study of Engineering Education" published by the Carnegie Corporation twenty years ago, Dr. C. R. Mann says,

"The ultimate aim of engineering education has always been and still is more intelligent industrial production. Technical schools were founded when industrial evolution had progressed so far as to create a pressing demand for men who knew how to utilize the new and rapidly expanding knowledge of natural science to increase and improve production. Science was then little taught in high schools and colleges, so that both the public and the manufacturers were ignorant of it. Under these conditions the obvious need was for scientific enlightenment; and this the engineering schools were organized to supply." The statements that the immediate aim was to supply the intellectual element in production, and that this meant knowledge of the fundamental principles of science, were true when they were first made in 1861.

Also from the same report: "The net result is that the curricula and methods of instruction that were devised to supply the intellectual element in production by imparting knowledge of nat-

ural science must be reorganized to meet the new industrial demand for engineering administrators and the larger professional demand for men of strong personality. The general plan of the proposed reorganization is based upon an analysis of engineering practice into its three essential factors; namely, knowledge of engineering science, skill in technique of application, and judgment in the appraisement of values and costs. In every engineering project the overlapping claims of these three essential factors must be harmonized with respect to the two fundamental elements of production, namely, materials and men. Surely every engineer should have some conception of the present conditions and problems in at least the general aspects of all these essential factors and elements. If this be granted, it is easy for any school to discover where its curriculum is overloaded and where it is deficient."

The recommendations which Dean Woolrich has just made regarding qualifications from secondary school, the provision for intermediate terminals in formal study, the strengthening of minimum requirements in subjects basic to the technology and culture of engineering and provision for post-collegiate forums are all easy to accept and fundamentally sound. Certainly professional demands are for a continuing education longer than institutional, broader than technological, embracing the humanities and obligations of public service. At the same time educators and society are concerned with the best way of meeting the needs of young men of varying talents both in aptitude and native ability. It emphasizes the fact that the problem is just as much human as it is technological.

Specialization vs. Generalization

To arrive at a reasonable conclusion as to the degree of generalization or specialization desirable in engineering education necessitates stating as clearly as possible those factors in which there is likely to be fairly general agreement. Among them the following are pertinent: first, the desirability of an individual's early determination of a life career; second, the necessity of providing flexibility in our educational system for the many who, for one reason or another, are unable to make such a decision; third, the desirability of sound, fundamental education in literature, arts, and science, which impart emotional stability, social understanding, character, and adaptability to later professional or industrial specialization; fourth, the necessity for stimulation which comes from directness of purpose and a close contact with practical application.

First of all it must be recognized that whether it is desirable or not, students must be educated for a more or less indefinite future. Secondly, if the idea is accepted that education begins and ends with life, the seriousness of a dogmatic answer is at once avoided, for it would seem to make little difference whether the individual aimed at a specific objective first, and at leisure pursued general educational improvement, or reversed the process. It is appropriate, therefore, to say something about the virtues of specialization not only in support of what exists but because it represents a natural, easy and effective process of development.

The development of engineering education reflects the virtue of the idea of "usefulness." Unfortunately, the zeal with which the basic sciences underlying construction, mechanics, mining, chemistry, and electricity were developed by specialists led to prescribed courses looking toward specialized education in these several fields. The practical result has been the injection of a great mass of science into heterogeneous industries. With time comes the realization that the traditional engineering courses do not find their counterpart in industry clearly defined. This has led to the feeling that a reorganization of engineering education along functional lines might be more appropriate. Careful scrutiny of this question discloses just as serious educational objections as the present organization offers. The most practical suggestion yet offered has been that of a bilateral subdivision or functional specialization of our traditional courses toward their termination. The most serious practical obstacle to this change lies both in the lack of suitable basic material upon which courses could be soundly based, and also in the limitations of time. The statistical discovery that the specialized curricula in engineering have produced a surprising number of industrial managers whose occupational pursuits in an executive capacity are frequently far removed from the science they studied has been used in rebuttal of the suggestion that courses be liberalized so as to specialize in the art of producing managers. Now, a few simple observations in industry will show that intensive application to specialized jobs or to specialized education has been the ladder upon which embryo managers have climbed. In fact, I believe it would be fair to say that this is so overwhelmingly true as to lend substantial proof to the theory that objectiveness or specialization in education or in industry are highly desirable. Gradually assimilated administrative experience is much more important than theories obtained in organized study. If this is so, it adds still more importance to emphasis on educational guidance and the sound building of curricula which, exhaustively, rather than superficially, drill the student in the fundamental sciences underlying the several professional choices.

It would also seem a fair conclusion that the many other subjects seeking admission through too much generalization could well be learned in the school of life. What is really important is a thorough knowledge of at least some useful pursuit, and a stimulation of desire to learn something about the social, economic and aesthetic aspects of problems related to those of immediate professional concern.

Dangers of Specialization

While the virtues of specialization are pertinent to this discussion it is just as important to recognize the dangers. Quoting again from Dr. Mann's report of twenty years ago: "The statement that individuality counts for as much as learning for the engineer, just as it does for the lawyer or the physician, seems like a veritable platitude. Yet because the engineering schools have always made it their chief aim to impart the technical information needed in industrial production, and because both scientific knowledge and industrial practice have grown so rapidly, the attention of technical schools has been focussed chiefly on keeping up to date in science and practice. The university emphasis on research in natural science has also tended to magnify the importance of technique and to minimize the importance of personality, until curricula have become so congested with specialized courses that students generally regard literature and sociology as unnecessary chores, to be endured rather than enjoyed. Therefore it seemed necessary to consider the question whether this emphasis on technique is producing a new and higher type of engineer, or whether the engineering profession still stakes its faith on the fundamental thesis that personal character is, after all, the real foundation for achievement."

In every occupational level there are too frequently those who have become self-satisfied because of a conviction of having attained expertness. They lack objectiveness in personal development, and assuming social responsibility, their mental growth ceases; new ideas fail to take root and further change of outlook is no longer a natural expectation. It is important, nevertheless, to emphasize that in the early years of a student's industrial career his chances of gaining recognition depend on his ability to surround the technical details of his specialized job. The danger is that in the intensity of his concentration and in the effort to attain a proficiency in his immediate work, he may not gain insight into the full intellectual and social bearings of his vocation. He may fail to develop interests in fields outside his immediate work. He may fail to develop an awareness of the evolving situation about him and may not sense the economic and social tendencies affect-

ing his own industry and job. He may capitulate to the demands of his immediate work and develop a warped or narrow viewpoint rather than a well-balanced education in book and life and an insight into the important elements of human experience

When such a man, because of good native ability, is given responsibility which requires coördination of the efforts of others he often discovers the need for those cultural and educational values tangential to his environment which he has had to forego in his early career. He finds that he has neglected those broader fields of knowledge which would have opened the way to generalizations and which would have provided resources for the imagination in arriving at proper conclusions. He sometimes finds himself striving in a world in which all sorts of complex economic and business phenomena are present, the causes and consequences of which he distinguishes vaguely or not at all. He lacks ability to absorb the lessons of experience in his environment, because he is not sensitized to the critical appreciation of their values.

If he senses his inadequacy and realizes that the evolution of the industrial world has proceeded faster than his own development, he will seek to equip himself with the tools and the technique with which to challenge vague impressions, emotions, and tradition, and reach sounder, more broadly considered conclusions on the business problems he faces.

If he does not realize his own lack of preparedness, or if he lacks the intellectual curiosity and stamina to bring himself up to date, he may soon be listed as human material which is obsolete, depreciated and inadequate.

Training Emphasis

If the genetic interpretation of the meaning of the word "professional" is permitted, the factors which have been discussed are important to the perspective of undergraduate education and certainly the professional phases are broader than technological.

In every educational program there are the elements of training. The term "education" is usually descriptive of a process of acquiring skills, attitudes, and knowledge to aid in meeting situations which cannot be determined specifically in advance. Education has objectives which are not as confined or as definite as those of training, which usually is restricted to organized learning-process procedure designed to meet a clearly defined problem or situation which is known in advance.

Among the important training objectives in professional engineering education I would emphasize the following:

Through the medium of English, report writing, and seminars,

develop facility in simple writing, direct speech, and concise thinking.

Through language, literature, and reading expand the vocabulary of students and their appreciation of word meaning.

Through drill in mathematical examples develop the use of mathematics both as a tool in the solution of problems and as a language in the expression of physical concepts.

Through drawing and geometry develop reasonable skill in picturing physical apparatus and engineering specifications in the mind of the student and for transmission to others.

Through shop and laboratory develop facility in handling machinery and as many types of measurement apparatus as are generally used in engineering practice.

Through the study of science develop facility in observing physical laws and forming clear physical concepts of them.

Educational Emphasis

Education implies at least the acquisition of knowledge and skill in applying it to new situations. The processes are continuous through life. The things to be known professionally are legion. An attempt to introduce as much knowledge as possible of any special field results in over-crowding and immediately introduces the problem of selection. What things are important? The things which open up or are basic to practices of broad application in the industrial world to-day or that can be foreseen in future work would seem to be the points of emphasis. In the field of technology an experienced teaching staff can usually sense the relative importance of subjects and drop or add courses from year to year.

In the desire to lay as broad a technical foundation as possible which includes the sciences of physics, chemistry, mechanics and professional technology basic to each of the several divisions of engineering, the values inherent in developing attitudes, appreciation, and understanding of the human factors in life-experiences must not be overlooked or crowded out of the picture, because it is in this phase of education that professionalism becomes distinguishable from trade occupation.

The color as distinguished from the content of professional practice has its root in culture, intellectual attributes and traits of character that determine public opinion and insure respect.

The united efforts of all engaged in the profession are necessary if we are to solve the problems of finding the best organization, of constructing the best curriculum, of selecting and developing the best students and of stimulating a program of life study under conditions that command respect and public recognition.

DISCUSSION

By GIBB GILCHRIST

A. & M. College of Texas

There seems to be no particular conflict between those who stress respectively the cultural phases and the professional phases of engineering education. It is merely a matter of time and four years are too short a period into which the desirable courses for an undergraduate engineer may be crowded. Into those fixed limits shall we increase the number and quality of our so-called cultural courses with a resultant decrease of opportunity for specialized technical subjects? Dean Woolrich very properly warns us not to forget that the true function of engineering education is to educate men as engineers and not as pure scientists. There will be no conflict between this warning and Dean Daggett's statement regarding undergraduate training: "Emphasis in professional subjects should be on the application of the basic principles of the engineering sciences, rather than on pouring into the student the maximum amount of information, much of which will be out of date before he is ready for professional recognition."

Mr. Eshbach debates specialization against generalization without specifically declaring a winner, but throughout his paper you note various phrases and some quotations to show that his real heart is in the fact that after all, personal character and high qualities of manhood form the real foundation for the engineering profession and for engineering education. No one will deny that this is true.

What has been our experience with professional courses? Have we reached a point where we can say with certainty that subject matter taught in those courses will be valuable for any reasonable period of time? Will the processes of thinking developed offset any loss as the course training itself becomes out-of-date?

Caution should be taken in the selection of non-technical courses to see that they are really basic and substantial. Dean Woolrich is believed to be right in his contention that the engineer should make the analysis and prescribe the adjustments needed as between general and professional courses. As a matter of fact, it seems that basic fundamental courses—probably some not on the calendar yet—should be carried just as far as possible in various engineering curricula and that specialization should be deferred as

long as the engineers of the profession think it can be deferred. There should then be intensive specialization, as up-to-date as possible, with at all times a foundation of fundamentals and a definite and directional objective. Specialization can and should be continued intensively after graduation.

It was my privilege, during the worst part of the depression, to be directing head of a public department employing several hundred engineers. While the principal portion of the work required men trained in civil engineering, many were employed whose college training had been in other branches. It was found that these men in the majority of cases adapted themselves to the work and were able by study and concentrated effort to approach the quality of performance of those who had received college training in civil engineering. It made me think that perhaps in our section of the country there had been some degree of overemphasis on specialized courses, but at the same time an excellent grounding in the fundamentals of engineering.

Dean Daggett states, "The professional status of most engineers today is entirely different from that of the lawyer or the doctor." But should it continue to be? Dean Daggett states further, "The great majority of engineers today are and always will be employees of corporate groups." Necessarily and properly, many of them should. It is distressing to think or to believe that our individual engineer is not destined to have a greater part in our scheme of life as an individual professional man. Can we not better train him to make himself a necessary part of community life? Is he not needed to a much greater degree in our county and city government? The adoption by many states of an engineers' license law will help and should improve the status of the professional engineer. A distinguished president of the American Society of Civil Engineers once said that the engineer, as a rule, was "inarticulate in the councils of men." This is quite true, and it should be extended to show that he has not only been silent but has scarcely ever been present.

To promote the profession successfully and to render the service to society that should be expected, the engineer must take a part in public affairs. He must take an active and intelligent part in politics. He must at times hold public office and he should be represented in the governing bodies of the state and nation. Of the various engineering colleges represented at this meeting, it would be interesting to know how many engineers are to be found on the various boards of directors or regents. The engineer is assumed to have been trained to lead, but in many ways he has chosen to follow. He is usually put in position to study and to recommend, but very seldom has he the right of veto. Particularly

where public funds are involved, he should have that power. During the past several years, how many of you have seen costly projects being constructed that could not in any way stand the test of economic usefulness and which, as a matter of fact, did not bear the stamp of approval of any reliable engineer?

To those of us responsible for engineering education, this represents a challenge. Engineering can and must be accorded the recognition given other professions. It is not enough that we send boys out into the world branded as engineers. We must equip them to meet other professionals on an equal basis and to take the position in the world of affairs that is rightly theirs. We must teach them to create for themselves and for the profession more fields of activity.

The question is—Will a broader general education planned principally by engineers give the graduate a better start? It would seem so, especially if arrangements can be made to assist him intelligently in his specialized course after graduation.

A. S. M. E.

The American Society of Mechanical Engineers announces the election on September 27th, 1938, of the following new officers for 1939, who will assume office on December 9, 1938:

President: Alexander G. Christie, Professor of Mechanical Engineering, Johns Hopkins University.

Vice-Presidents: Henry H. Snelling, Senior Member, Snelling & Hendricks, Washington, D. C.; Wm. Lyle Dudley, Vice-President, Charge Design and Sales, Western Blower Company, Seattle, Wash.; Alfred Iddles, Application Engineer, Babcock & Wilcox Company, New York, N. Y.; James W. Parker, Vice-President and Chemical Engineer, Detroit Edison Company, Detroit, Mich.

Managers: Clarke Freeman, Vice-President, Charge Fire Prevention, Engineering and Underwriting, Manufacturers Mutual Fire Ins. Co., Providence, R. I.; William H. Winterrowd, Vice-President, Franklin Railway Supply Co., Chicago, Ill.; Willis R. Woolrich, Dean of Engineering, University of Texas, Austin, Texas.

CIVIL ENGINEERING PAGE

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CONFERENCE ACTIVITIES OF THE CIVIL ENGINEERING DIVISION

STRUCTURAL PRACTICE CONFERENCE

Armour Institute of Technology, Chicago, Ill., June 20–23, 1938

The S. P. E. E. Summer Conference on Structural Practice, a function of the Civil Engineering Division, was held in Chicago, Ill., June 20–23, 1938. The Armour Institute of Technology coöperated by furnishing its facilities for the use of those present. Registration totaled 65 persons, representing all sections of the United States.

The first day was devoted to papers and an inspection trip sponsored by the Portland Cement Association. The meeting of the second day was held in Gary, Indiana, under the sponsorship and at the plant of the American Bridge Company. The third day was sponsored by the Chicago Bridge and Iron Company with papers by their engineers and an inspection of their plant. The final day featured papers on steel construction and an inspection trip of the Chicago River Bridges by boat. Accommodations were furnished by the City Engineer's Office.

The banquet the evening of the third day was attended by 75 persons, including several ladies. A resolution was passed to the effect that Armour Institute of Technology should express the appreciation of those attending the conference to the coöperating organizations. This resolution was fulfilled.

REGIONAL SURVEYING TEACHERS' CONFERENCE

University of Louisville, Louisville, Ky., September 5–8, 1938

The second Regional Conference on Surveying and Mapping, under the auspices of Committee VIII, Surveying and Geodesy, of the Division, was held at the University of Louisville, early in September. 122 representatives from 24 colleges and 26 governmental bureaus, departments, and commercial organizations were registered. This number does not include 17 wives and children of the representatives who were present. Sixteen mid-western, eastern, and southern states were represented by those in attendance at the conference. Registration took place in the Administration Building of the University of Louisville on Monday afternoon. That evening sight-seeing tours were made to various points of interest, transportation being furnished by the Louisville District, U. S. Engineer Office. Good weather prevailed during the entire meeting, and a very profitable conference was acclaimed.

Professor George H. Harding of the University of Louisville, Chairman of the Conference Committee, presided at the dinner meeting, Monday evening, held at Otter Creep Camp. The Camp is situated 33 miles from the University Campus and is maintained by the National Park Service. Dr. Raymond A. Kent, President of the University of Louisville, gave the address of welcome.

No attempt is made in this news report to cover fully the conference. A summary of the program and conference activities, with speakers and the topics or discussions, will be included in one of the issues of Volume IV, Civil Engineering Bulletin of the Division.

The members of the conference and visitors wish to express to the University of Louisville and the local committee their thanks and appreciation for the considerations extended in their behalf.

ENGINEERING ECONOMY PAGE

Engineering Economy is the phase of engineering work in which technical plans and operations meet the critical and constructive test of applied economics.

EDMUND D. AYRES, University of Wisconsin, *Editor*

THE REPLACEMENT ECONOMY PROBLEM IN THE CLASSROOM

Scene: Your classroom and mine

Professor Dooley Clear: The replacement problem in general can always be handled properly by assuming the "first cost" of existing equipment as its "net salvage value," that is, as its "second hand value with cost of removal and other necessary pertinent incidentals considered." This "recoverable capital" or "net realizable value" at the time of the replacement study is obtained absolutely without regard to any unamortized values left on the accountant's books.

Will B. Practical: Professor, I read what you have just stated in the text last night and talked to dad about it. He said that they got at this problem down at the shop with formulas which recognized the unamortized values of the equipment considered for replacement. He said that even if this "sunk cost gospel" is right, and he took quite an interest in reading about it last night, why, an ordinary engineer would have a tough time getting a boss who had never heard of a sunk cost to accept it. Why, he says, you know the boss might have to go on the carpet before the board of directors and explain to them any big unamortized loss incurred on the books of the company. He says, it looks to me son, that even if your sunk cost theory is true, I would have to take your professor along first to convert my boss and the boss would need him to spread the gospel to the board of directors. You tell your professor that he is bumping up against something there—if he can get a method mathematically equivalent which will not make every young engineer an evangelist, then he has something practical. Of course when you young engineers get to be bosses you will be educated and can do your own arguing with the board of directors—but I am thinking that even then showing them your method as equivalent to one they will accept is a pretty practical way to approach this spreading of a sunk cost gospel.

How do you treat this practical problem?

ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS
OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*

ENGLISH FOR ENGINEERS

SUGGESTIONS FOR IMPROVEMENT OF WRITTEN ENGLISH IN AMERICAN SCHOOLS OF ENGINEERING

Communication is dependent upon a common language. The sending forth of thought is only half of the transaction; if the wording is misunderstood the result is a failure.

Native language, being first learned in infancy by imitation of parents and associates, is acquired easily and unconsciously. Likewise gradually the vocabulary of a child is extended by the widening of his horizons. Thus when college is reached much may be taken for granted as to the ability of the youth to develop the more exacting technique required for effective writing.

Some rhetoric and composition, to be sure, are usually expected for a degree of Bachelor of Arts, but not always will such subjects be welcomed as opportunity for learning; the average student is inclined to slight them either as dry superfluity or as troublesome interference with important work. Especially has this been so in schools of engineering; and that comes directly to the subject: English for Engineers.

The engineering student is preparing for work in the world. Those subjects that he believes can be applied directly to the getting and holding of a job are the ones to him most interesting. Time required to be spent upon the humanities is apt to be given grudgingly. And he will deem especially oppressive a requirement to attend a general English course, along with those he considers less robust, outside the work-a-day atmosphere of the Engineering School. In fact it is but natural that the activities of the bridge and the engine deck will be more attractive to him than the quiet and unspectacular compilation of the log of the voyage.

For these reasons it is suggested that technical English can best be taught within the School as an engineering subject. The students' interest may there be aroused by a teacher who is in sympathy with his practical ambitions. Indeed, the student may be led to conclude for himself that his ability as an engineer will be rated

largely on the basis of clarity of business letters, precise wording of specifications, and the comprehensiveness of engineering reports.

As a further help toward gaining the students' attention, such precepts might be enlivened by selected examples of mistakes that have spoiled serious papers and ruined all of their intended effect. Practical problems could be given in the form of lists of promiscuous facts to be sorted according to relevancy, and classified for effective arrangement in a finished paper. Results could be observed by inspection of the students' laboratory note books, examination papers and research theses.

It has been said that a student may feel resentment at an implication of deficiency in his native language. But, whereas such a barrier to creditable results might be raised by an attempt to correct general English, it is believed that the approach from the technical side should not engender opposition any more than do the courses in physics or chemistry. It ought to be obvious to the student that he has no more had occasion to learn the one than he has the others in his former preparatory life.

With these thoughts in mind it is proposed that technical writing, to be effectively taught, should have an engineering presentation. Indeed, it is submitted that unless English is so taught the engineering training is not complete. The results of a land survey are not generally useful until they have been plotted on a map; likewise, the achievements of research are not publicly beneficial until adequately clear words have been written down for their description.

Finally, with the coöperation of all of the engineering faculty toward such an end, the student should be enabled to acquire facility of expression suitable to the commanding position he expects to fill. Thus he will benefit himself and, at the same time, reflect credit upon his profession and upon the school where he received his engineering training.

ROY J. BARBER,
Dean, School of Mines,
University of Alaska.

THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

F. M. PORTER, *Editor*, University of Illinois

BY-PRODUCTS OF ENGINEERING DRAWING TEACHING

Occasional mention is made of the peculiar responsibility resting upon the drawing staff in view of the freshman engineer's having in that department his sole contact with an engineering subject. The implication seems to be that there is some particular quality of training he needs, which, if not supplied by the drawing teacher, he misses altogether.

Merely to define efficient engineering teaching suggests much than can be done to meet this obligation. It is more than inducing students to learn their modicum of drawing, mechanics, thermodynamics, power plant design or theory of alternating currents. With the generally recognized trend today toward greater complexity of life, the effective teacher should lead those under him to a quick and easy mastery of his incidental subject material; to an evaluation and orientation of that subject content in relation to professional engineering experience; to a self-disciplining whereby, in the multiplicity of modern surrounding distractions, he will determinedly stick to a set course; to a recognition of the democratic principle that accomplishment, advantage and other rewards are earned, and not gifts rained down; to the acquirement of an outlook on life which embodies many of the fine old virtues of honesty, industry, integrity, justice, and their exemplification in both professional and layman living.

Probably no two instructors will employ like techniques in achieving these ideas and ideals. During the frequent personal contacts with his pupils in the course of a semester or a year in the discussion of their problems of registration, health, self support, methods of study, outside reading and the like, the skillful teacher finds abundant opportunities to insinuate and illustrate many of the objectives outlined above. In the class room, a remark on, say, the interest the engineer should have and the responsibility he should assume in local and other government, dropped casually but fittingly in the discussion of any technical problem, has tremendously more emphasis than if uttered in a formal lecture on civics.

There is ample time in the busiest schedule for the unobtrusive and effective introduction of these elements. Admittedly they are here somewhat overdrawn. But what immeasurable enhancement of engineering teaching might be seen in the year now begun if every instructor could impress just a few of his students with even a trace of but one of them!

COLLEGE NOTES

In accordance with an expansion policy that has been under way for a number of years at **Armour Institute of Technology,** several new professors have received appointment to the Institute staff. The first of these is L. Mies van der Rohe, famous European creator of modern architecture, who receives the post of Professor and Director of the School of Architecture. In order to execute plans that he has for the School of Architecture, L. Mies van der Rohe will have the assistance of the present staff of the School of Architecture, and in addition will have the assistance of two new professors—Ludwig Hilberseimer, Professor of City Planning, and Walter Peterhans, Professor of Visual Education. John B. Rodgers, also in the Architectural Department, has received appointment as Assistant in Design.

Hans Reissner, famous for his scientific aeronautical researches, a native of Berlin, Germany, and a noted structural engineer in the United States, received appointment in the Mechanics Department as Lecturer in Mechanics. He will also serve on the staff of the Institute's Research Foundation. As a staff member of the Foundation, Dr. Reissner will be carrying on two research projects for the National Advisory Committee for Aeronautics.

Myril B. Reed, who receives appointment to the Department of Electrical Engineering as Assistant Professor of Electrical Engineering, comes to Armour Tech experienced in the teaching of all courses offered to students of Electrical Engineering. He received his undergraduate training at the University of Colorado and his postgraduate training at the University of Texas, from which he received the Ph.D. degree in physics in 1935. He has also studied at the Electronics Institute (summer of 1937) at the University of Michigan and spent considerable time in electrical engineering field work with such companies at the Public Service Company of Colorado, the Utah Power and Light Company, and the Westinghouse Electric Company, Meter Division. He is the author of the textbook, "Fundamentals of Electrical Engineering," and is at the present time writing the second volume of the latter work.

John L. Miller, a graduate of Harvard University, received appointment as Associate Professor of Metallurgy. He comes to the Institute from a position as research metallurgist for Babcock & Wilcos Company of Barberton, Ohio, with whom he has been associated since 1932. He received his undergraduate training at De Paul University here in Chicago and then, after spending four

years as research chemist and metallurgist with the American Sheet and Tin Plate Company, studied at Carnegie Tech and the Harvard Engineering School.

Sanford B. Meech, a graduate of Yale, B.S. '24, Ph.D. '29, joins the English Department as Assistant Professor of English and comes to the Institute from the University of Michigan, where, since 1930 until the present, he has served as Assistant Professor of English Language and Literature. Since his graduation from Yale he has served as Instructor of English Literature at Allegheny College and at Hunter College. He was assistant editor of the Middle English Dictionary and has published "The Book of Margery Kempe," a literary anthology of middle English—the latter in conjunction with Professor W. O. Ross of Wayne University and Professor E. M. Weatherby of the University of Missouri.

William L. Wasley who joins the staff of the chemistry division of the Institute as instructor of organic chemistry, received his undergraduate training at the University of Chicago, B.S. 1935. In 1836 he was awarded a teaching fellowship to the State University of Louisiana and received his M.S. there in the summer of 1936. From 1936 until 1938 Dr. Wasley served as a Park, Davis & Company, research fellow at Stanford University, where he received his Ph.D. in chemistry. He is a member of the American Chemical Society and Sigma Xi.

Carnegie Institute of Technology.—Willard E. Hotchkiss, former president of the Armour Institute of Technology and an expert in industrial management, has been appointed Maurice Falk Professor of Social Relations at the Carnegie Institute of Technology. Assuming his duties immediately, Dr. Hotchkiss will organize the new program of social studies for engineering students at Carnegie Tech, thus getting under way an educational project which has been planned by President Doherty for several years and which is made possible by a grant of $300,000 to the Tech endowment by the Maurice and Laura Falk Foundation of Pittsburgh.

Dr. Hotchkiss is one of America's outstanding educators. He has had a constructive career both as an educator and in public affairs, having served several leading universities as administrator and teacher, and having been adviser and organizer for numerous governmental and industrial projects.

The program of social studies which Dr. Hotchkiss will organize will be in keeping with the objectives of the Falk Foundation in solving problems of economic and social relationships. The program of social studies will have as its objective the development in the young engineer of a social consciousness and social responsibility. To attain this end and there will be set up a program of related social and cultural studies in the College of Engineering

to run throughout the four-year college period of attendance. These courses will consume perhaps one-fourth of the student's total educational time, the remainder to be devoted to the usual engineering and scientific subjects.

Through this program it is hoped to bring about in the mind of the student a clear historical understanding of the parallel growths of science and engineering on one hand, and social customs, relations, and institutions on the other—in other words, a social consciousness and historical perspective of social evolution, especially since the invention of the machine. While these are the broad objectives of the program, it will necessarily take some time to get such a plan fully in operation. So at the inception of the plan, a small group of students will be selected to study under Dr. Hotchkiss. The course will consist principally of extensive reading in relation to selected problems under professorial guidance, with reports and critical discussions at seminars.

In addition to this program of undergraduate studies there will be established by Dr. Hotchkiss a second educational project which will provide for a continuing, long-range research study of the ever-changing social relationships in industrial and business life. In the development of this program, industrial, civic and professional leaders of Pittsburgh will be brought into consultation. Organization of this research program will be begun after the undergraduate project is successfully started.

SECTION MEETINGS

ALLEGHENY—University of Pittsburgh, November 4–5, 1938.
MIDDLE ATLANTIC—New York University, December 10, 1938.
NEW ENGLAND—University of Maine, October 8, 1938.
NORTH CENTRAL—Michigan College of Mining and Technology, October 7–8, 1938.

G-E Campus News

THE BABY GROWS UP

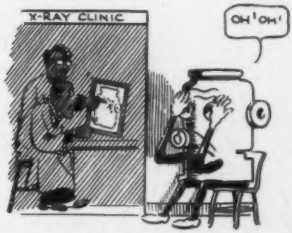
SIXTEEN years ago G-E radio engineers crossed their fingers and snapped a switch in one of the laboratories at Schenectady—and a split second later heard through clumsy earphones, "This is WGY, radio broadcasting station of the General Electric Company, Schenectady, New York."

That was the "birth announcement" for this G-E station, whose rise from swaddling clothes to the lusty strength of sixteen years has paralleled the rise of radio broadcasting from experiment to smooth efficiency.

From the start, WGY was an unusual child. When only three days old, it started pioneering by presenting the first remote-control broadcast. And the pioneering is still going strong. As the station grew, it provided the groundwork for network broadcasting, mobile transmission, coast-to-coast television broadcasts.

This year, WGY celebrates its sixteenth birthday with a new 625-foot nondirectional antenna (70 feet higher than Washington Monument) and a modernistic new studio building with everything from a model kitchen to a large audience studio.

Engineers conduct tests on the young giant day and night. Some are the veterans who started years ago—others are recent graduates of engineering schools assigned to the control rooms and transmitters upon completion of their G-E training courses. Results of the tests these two groups conduct today will appear as refinements in the broadcasting of tomorrow.



ELECTRICAL TROUBLE SHOOTER

TWO men are carefully examining a large x-ray photograph in a darkened room. One of them points to some dark spots, some wavy lines . . . "There's the trouble."

This might well be taking place in a large medical laboratory. Instead, factory production lines and machinery are only a few feet away—it is a testing room in which x-ray photographs of steel castings are examined. In many such rooms, in all parts of the country, other engineers are making like tests—tests that ferret out defects in castings before they can cause trouble.

Knowing in detail the symptoms of every defect, these engineers, guided by the x-ray, detect gas pockets, shrinkage areas, and internal cracks. They eliminate all but "smooth" castings.

Such applications, of which many persons are not aware, are typical results of the constant search by G-E engineers for new uses of the x-ray. And not all of these engineers are veterans—some only a few years ago completed their studies in engineering schools and came on Test with General Electric.

GENERAL ELECTRIC

90-86FBI

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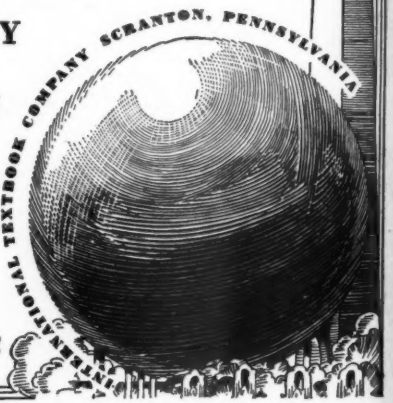
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